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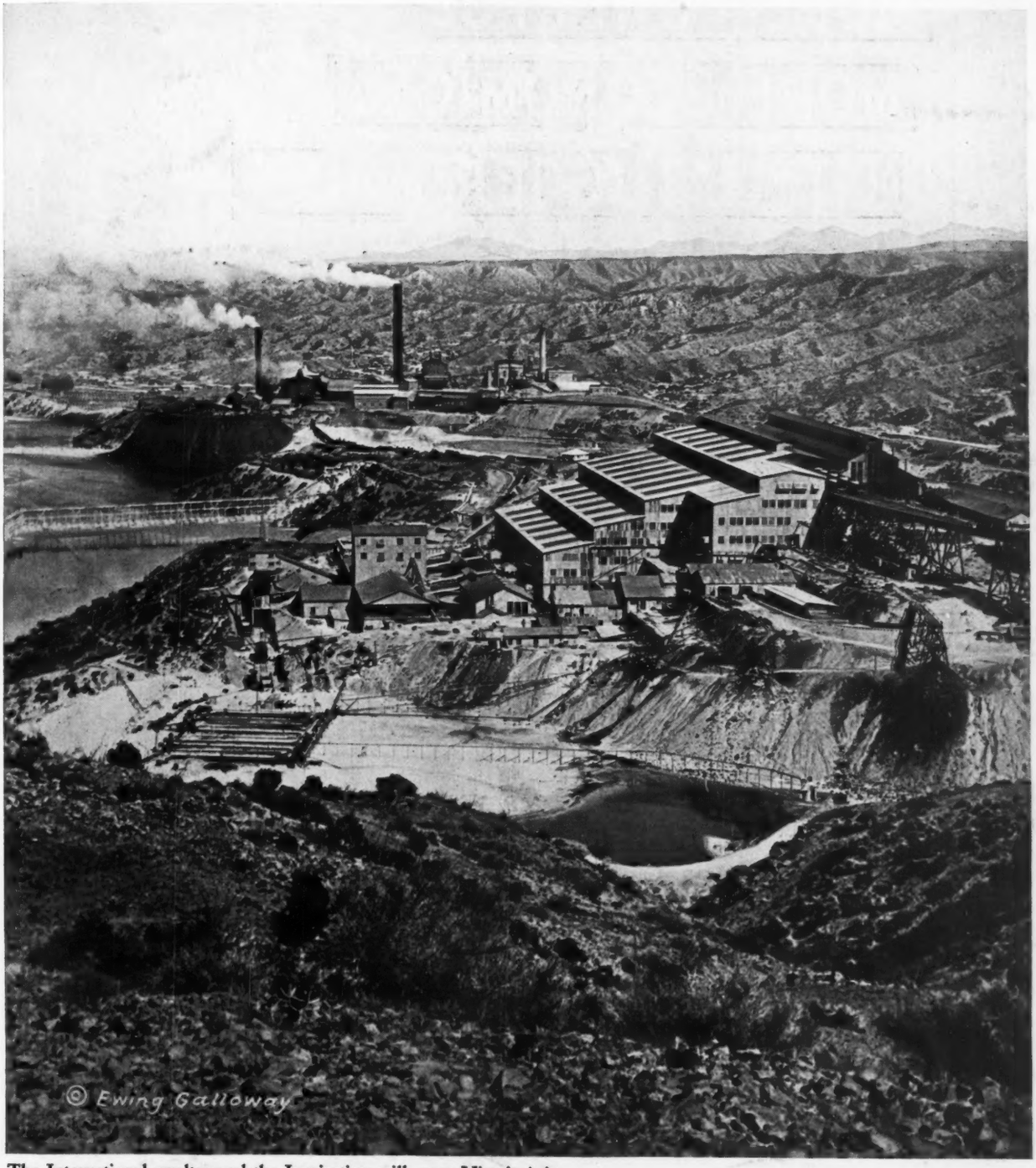

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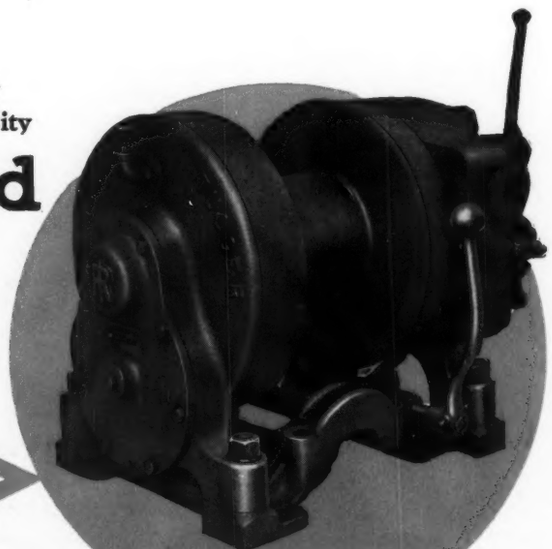

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MINING JOURNAL
A McGRAW-HILL PUBLICATION

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Contents for March 24, 1930

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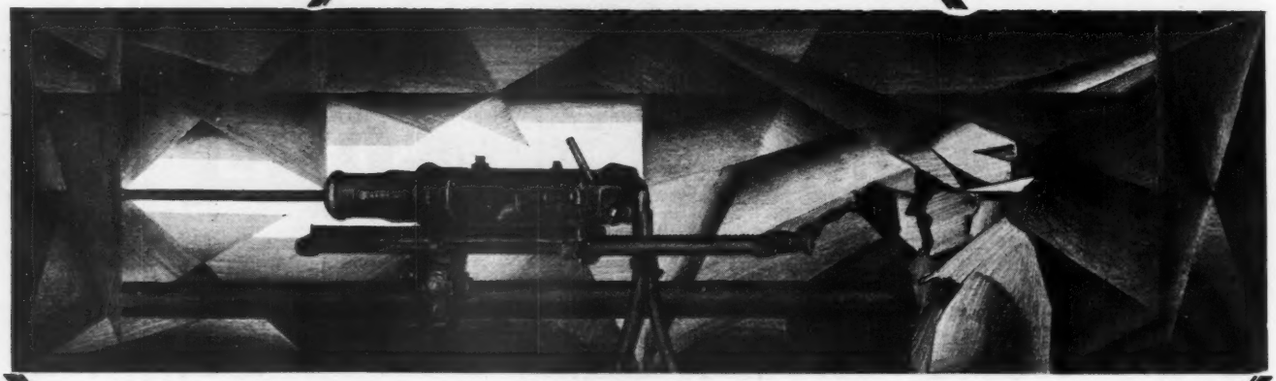

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ENGINEERING AND
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JOURNAL

A. W. ALLEN, *Editor*

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ESTABLISHED 1866

VOLUME 129, NUMBER 6

New York, March 24, 1930

Gold Production and Commodity Prices

NOTHWITHSTANDING new high records of gold production in South Africa and Canada last year, world output was little, if any, in excess of that in the preceding year. In fact, a uniformity in this respect in recent times, with the knowledge that steady although small declines in output from some gold fields are noticeable, has caused some of the leading economists in the United States and in Europe to suggest the possibility that insufficient metal may be available to meet credit demands, arising from the normal expansion in world business. Should a shortage of gold occur, some aver, its purchasing power, under the present gold-basis financial scheme, would increase, commodity prices would collapse, and, with credit curtailed, business depression and hard times would follow. This is the gloomy picture they would paint; but, in fairness, it should be added that they also see in the adoption of wise international control of gold supplies, and by other remedial measures, an avoidance of any such calamitous situation.

To be forewarned is, perhaps—so far as a possible gold shortage and world banking developments are concerned—to be forearmed. At least, such an assumption is warranted. And for the forewarning, credit must be given the economists. They would not have been fulfilling their duty had they remained silent. The mining industry, however, can contribute to the discussion of the subject the information that the waning of gold production may be only temporary. For instance, although the gold output of the United States and that of Australia will probably continue to decline, that of the Witwatersrand may be expected to be maintained for several years at its present very satisfactory rate. Canada's production will increase, and more gold may be forthcoming from South America and Mexico. Unexplored and undeveloped areas of Russia, Africa, and Canada, not to mention New Guinea and Central America, offer possibilities for finding new gold deposits. The prospect for cheaper and quicker transportation, improved technique in prospecting and mining, more efficient and more economical metallurgical practice, and the consistent record of important gold discoveries during recent times—all these factors lend encouragement to the belief that after the next few years a gradual increase in world gold production is likely.

The possibility of a gold shortage is a challenge to the banking world to develop ways and means to meet such a contingency should it occur. Such financial machinery as might be necessary could be evolved to cope with any such situation. In brief, therefore, the warning voiced by economists should occasion no alarm. Accumulation and use of money, "as is," by the individual and by business, without fear of a collapse of commodity prices as a result of a possible shortage of gold, would appear to be a safe and sane procedure.

Ethics—And the Employment of Engineering Graduates

FORMULATION of a code of ethics generally follows recognition on the part of interested agencies that unsuitable conditions prevail in the sphere to which the code pertains or that the development of such conditions is threatened. The directors of technical educational institutions and of industry have apparently felt that the circumstances surrounding the employment of engineering graduates have not been satisfactory, for at the tenth annual Industrial Conference, held at the Pennsylvania State College, a code was adopted that will be put into practice by many of the conference members in connection with the employment of technical students who graduate next June.

Study of the code encourages the belief that conscientious adherence to its provisions will operate to the advantage of all concerned, but particularly to the young engineer entering on the practice of his profession. This is as it should be. The opinion has been gaining ground in recent years that the annual crop of engineering students has been exploited by some of the larger companies. One of the principal grievances voiced against such organizations is that they have taken into their employ a far greater number of young engineers than they required, with the idea of selecting, after a certain period, a few of those best equipped to fill the small number of desirable permanent positions that are then available. Such a procedure is not fair either to the young graduate, to the technical school that educated him, or to industry at large, which ultimately will suffer from so wasteful a practice. This is only one of several unsatisfactory conditions, all too common in the past and to some extent prevailing at present, that would be remedied by an observance of the restrictions in the code that has been proposed.

Common sense, fair dealing, and the exercise of foresight seem to be the principles on which the new code is founded. Both the educator and the employer are asked to consider as of primary importance the interest of the student, as a prospective citizen and as a prospective member of the engineering profession. Every effort is

made to urge the development of the understanding between the engineering schools and industries that is necessary for intelligent co-operation. According to the code:

The Employing Company should (1) furnish full and not too optimistic information regarding working conditions, opportunities, and rate of advancement; (2) select only the number of graduates required according to a careful estimate of conditions; (3) allow the student a reasonable time after employment opportunities are presented to become familiar with other opportunities before making a decision; (4) act promptly on all applications; (5) secure the consent of the student to any contemplated change in the employment agreement; (6) not employ a student known to have entered into an employment agreement with another, unless consent of the other has been obtained by the student; (7) avoid prejudicing the student against the opportunities afforded by other companies; (8) provide opportunities to enable each graduate to develop his latent possibilities to his own advantage as well as to the advantage of the company and of society.

The Engineering School should (1) not accept fees for continued instruction of students who obviously will not later qualify for engineering work; (2) supply unbiased information and advice regarding the various opportunities for employment; (3) not hamper the student in his freedom of choice in employment; (4) not refer employment possibilities to the employed graduate, except upon his application, or attempt to separate the graduate from his employment without first having discussed the matter with his employer.

The Graduate Engineer should (1) supply full and correct information regarding his experience and background; (2) accept only one position at a time; (3) secure the consent of the employer before changing the employment agreement; (4) not accept training in a special training course, with the intention of using it in the interest of another, without the consent of the employer.

The exercise of engineering principles is evident in the code, for it would primarily effect a much more intelligent and efficient utilization of technical training. More important, however, is that, having secured the universal endorsement and wide application it deserves, the code should be an outstanding though perhaps indeterminate factor in scientific and industrial advance.

A Better Annual Report—Artistically and Financially

ALL too often the importance of a mining company is inversely proportional to the luxurious appearance of its annual reports, but this rule does not always hold. For example, farthest north in the realm of de luxe reports received in the last year comes from a large, well-managed, progressive company that has been in business for almost forty years and last year showed a net profit of more than two million dollars. Until 1930 its reports have been rather prosaic-looking compilations of figures, but the thirty-eighth one, now in the hands of the stockholders, is gorgeous, with a purple reproduction of a night photographic study of its blast furnaces on the cover, and most attractively printed text on hand-made deckle-edge paper inside. Heretofore, at the bottom of the initial page, one has merely read "Denver, Colorado," but this time appears the appropriately prouder legend, "Printed at Denver, Colorado."

Having commanded this editorial notice, it is a pleasure to record the fact, more important to stockholders doubtless, that the net profit of the Colorado Fuel & Iron Company in 1929 reverted to its former level of between two and three million dollars, after having been but a little over a million in 1928. The holders of common stock must, however, be patient for a little while yet, for most of the earnings are being put into capital account. More than seven million dollars' worth of bonds have been retired since the termination of the World War, preferred dividends have been paid, and over five million dollars has been applied to writing off undepreciated values of dismantled equipment. The progress made by the mining and metallurgical industry, and the investment necessary to keep such an industrial enterprise up to date and able to meet competition, is indicated by the fact that in the last eleven years more than seventeen million dollars has been spent for replacements, new construction, and improvements.

By its current exhibit the company shows that it has spent a few dollars on improving its annual report as well as its plants. The only criticism that might be made is that of the twenty-four pages available, ten are absolutely blank: a little more information about the technical operations of the company might be included, even at the sacrifice of the admittedly artistic effect of clean and beautiful paper.

Rare-Metal Research an Example of Versatility

THE designation "rare metals," according to a classification not based on chemical or physical properties, is intended to denote a scarcity of ore supply or difficult and costly methods of reduction and refining. Great progress has been made in this field during the present century. Many of the rare metals, formerly of major interest as exhibits in the show cases of a museum, are now being usefully applied in the workshops of industry, where their introduction has wrought important and far-reaching changes.

Improved alloy technique, a revolutionized tool industry, the incandescent lamp, radio, and television are some of the achievements made possible by the use of rare metals. The development of acid-, heat-, and corrosion-resistant materials has provided the chemical engineer with equipment essential to the progress of his industry. This development has not been the result of luck or chance. Behind it lie years of tireless and systematic research. Interesting in this connection is the versatility that has been exhibited by those engaged in the work. A thorough study of physical properties and the refining of the metals had to be conducted simultaneously, to develop uses and to provide markets that would insure economical as well as technical success. The development of tantalum is a typical example of such research. Hardly known twenty-five years ago, tantalum

has won for itself a distinct place in the manufacture of rectifiers, in radio technique, and in the chemical industry, and continued research is constantly adding to its usefulness. Lithium, a metal of unique qualities, has attracted considerable attention as a hardening agent, imparting to other metals—even when only a minute amount is added—a degree of hardness that cannot be obtained by other means. Hardened aluminum alloys have been developed, and some lead alloys used as bearing metals, originally intended as substitutes for similar lead-tin alloys, have proved superior in many qualities and are gradually conquering the field.

Vanadium, well known for its use in special steels, is likely to enter the field of catalysts, in the manufacture of sulphuric acid, in the oxidation of ammonia, and in organic oxidation processes. An important future is prophesied for beryllium, although the scarcity of supply and the present high cost of production hardly seem to warrant undue optimism. Intensive research, however, is being conducted in Germany and in the United States, and drastic cuts in price have been forecast for the near future, to place the metal within the reach of the aircraft manufacturer, who expects to take advantage of its great strength and lightness.

Such examples of the successful application of research to the development of the rare metals should inspire investigators in correlated fields. Some of the producers of the commoner non-ferrous metals, many of whom are facing the problem of overproduction and deflated prices, the result in many instances of a failure or inability to co-ordinate production with consumption, have been forced to meet the situation with drastic curtailment in output. This, however, can serve only as a temporary means of relief. Intelligent studies of distribution, systematic research to stimulate consumption, and aggressive selling are necessary. Fortunately, many signs of the times are indicating that the problem of consumption is receiving increasing attention, and that the producers are no longer inclined to wait for the customer to come and be served. Like Mohammed, they are awakening to the fact that personal effort is required to reach the mountain.

Effecting Operation Economies by the Use of Zeolites

ONE of the most intriguing of the many phenomena associated with the utilization of mineral products is the base-exchange property exhibited by the group of hydrous silicates known as zeolites, which, because of this characteristic, are extensively employed for softening water—a process that presents the paradox of an insoluble reagent effecting changes in solutions. The action is of particular interest, though not resembling any commonly found in ore-treatment practice.

Impure water in passing through a bed of zeolitic sand has its calcium and magnesium content replaced by sodium. This interchange continues until the sodium of the zeolite has been exhausted. When this condition is reached, regeneration of the softening medium may be effected by treating it with a solution of sodium chloride, the calcium and magnesium on the zeolite being replaced by sodium and going into solution in the brine. Thus it is possible to use the zeolite over and over without deterioration of its useful properties.

Either a natural or a synthetic zeolite is employed, but the natural product, owing to its superior resistance to carbon dioxide, organic matter, and iron, which are found in large quantities in some waters, has almost replaced the zeolites made by synthesis. Deposits of glauconite or greensand in New Jersey provide the raw material, which, following processing, is dark green to black in color and fine grained. Open-cut methods of mining are employed, but extensive drainage and pumping are necessary. The deposits imprison large amounts of water.

In the zeolites the mining industry has provided a material that has effected economies at innumerable plants utilizing large quantities of water, particularly where steam power is employed. The operations of cleaning and replacing boiler tubes are reduced to a minimum, and the quantity of water evaporated per unit of fuel is increased markedly in most instances. Hard waters are commonly found at mines. At various properties, particularly those where operations are on a moderate scale, an opportunity exists for the industry profitably to make more extensive use of the zeolite water softener.

Varied Technique of Mining Promotion

METHODS adopted to induce the public to invest in alleged precious-metal mines with large reserves of high-grade ore are legion. A new note was recently struck, however, by a "mine operator" in Denver, who is using the mails to seek funds for some purpose not ostentatiously disclosed. The property appears to be so valuable that one wonders why the easier course of recovering some of the "values" is not followed. The letter states that "already there are some 150,000 tons of ore broken, ready to be treated at the mill. . . ." The mine "is a mile long with over one and a quarter miles of underground workings. It is equipped with all essentials for mining operations, including power plant, ore compressor, machine drills, etc. Both high-grade and milling ores are produced. It is considered a very large gold-copper-silver mine, principally gold. It has a production record of about $500,000. It is not a prospect but a real mine."

The selected victim is challenged. "Have you the nerve to outlay $10" is the question asked. "It is a unique proposal and, for one reason, I am presenting it to determine whether or not you have courage enough to risk $10 in my keeping for a short time with absolutely no chance for your losing it, if you ask for it back in the time specified." Nothing apparently could be fairer.

Wall Street, however, is less considerate. A recent appeal from a "Mining and Smelting Company," the promoters of which have the temerity to abstract and incorporate in their prospectus a letter that appeared in *Engineering and Mining Journal* to prove that such a thing as luck exists in mining, states that honesty is the best policy. The reader is advised that "there are plenty of people throughout the world able to buy shares in a mining company without it being necessary to take money from orphans or widows, helpless cripples or

invalids." "The information and suggestions in these pages," one is warned, "are not for you unless you can afford to take a chance of $10 or more without it's hurting you or depriving those dependent on you of necessities." The stock is described as a "gilt-edged issue," and the mill is said to be operating at an efficiency whereby "every ton of ore is yielding over 35 per cent lead concentrates which represents approximately $40 per ton."

The statement is made that ". . . only an uninformed person thinks that something must be wrong if he is given a chance to buy some shares in a reliable, legitimate mining enterprise. . . ." The ore is expected to give a net return of $20 per ton, and figures are displayed indicating a profit of 15 per cent on the investment with the existing "mill"; and 138 per cent per annum when the larger mill that is planned is operating. "These figures are conservative," the reader is advised, "and take no account of the probable rich shoots of ore worth in the thousands of dollars per ton."

From Denver, also, comes the warning that "You have it within your power to determine your future. What will it be?" Statistics are given to show that $500 invested in the original Bell Telephone Company would now be worth $2,000,000, and "$500 invested now with us has just as good chances to grow to a fortune. . . ." The secret is to invest your money in a company sponsoring a new metallurgical process, based on the theory that "what chemistry has united, chemistry can separate." This invention is said to make possible "a complete recovery of the gold, silver, copper, and other values too numerous to mention. The ore for treating at the mine is crushed to 40-mesh, then it is fed directly to the rotating electric furnace, and the finished material is obtained in the large tanks, or vats, and through the application of the chemical reagents, or active agents, made ready to be sold to the manufacturer or consumer. The gold and silver is sold direct to the United States mint."

From San Antonio, Texas, comes a fourth appeal, made by an individual who takes advantage of a well-known method adopted by institutions of doubtful permanence. Cash disbursements are made to those investing, equivalent to a small percentage of their investments. This is quoted as a record of worthwhile achievement, and a clinching proof of genuine value. The prospect is warned as follows: "Resolve that you will not let another cash disbursement . . . pass you by—or risk missing out on one of those rich bonanza strikes making possible a huge lump sum disbursement, or take chances on sudden over-subscription, which seems an early certainty, taking this unusual opportunity from your reach forever." The mines are stated to be monstrously rich. The prospectus avers that "Success is already ours! Victory for us is here now! Disbursements already paid out stand as proof. . . . And these 3,000,000 tons of ore, known to exist, stand as our guarantee of enduring, lasting prosperity? Just as these undeveloped veins and that record of colossal bonanza strikes stand out as our opportunity for huge, outright wealth—gigantic riches!"

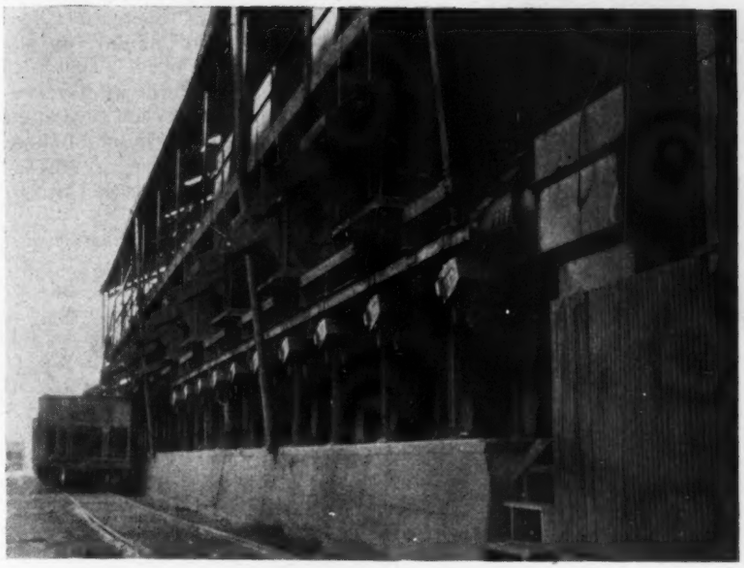
How long is the mining industry of the United States to suffer from irresponsible promotions of this character? The harmful effects are both direct and indirect. Confidence is shaken in precious-metal mining as an investment opportunity; a competent mining engineer has no say in matters that affect his standing; and a continuous flow of capital is being insidiously diverted into channels that offer no reasonable hope of financial return.

Rand Production, Costs, and Profits in 1929

Company	Tons Milled	Gold, Oz.	Dwt. per Ton	Total Revenue	Costs per Ton	Working Profit	Profit per Ton	Dividends Paid
Brakpan Mines	1,028,300	399,246	7.765	£1,691,751	20s. 3d.	£650,733	12s. 8d.	£497,250
City Deep	1,083,000	295,615	5.459	1,257,251	25 10	140,126	2 7 Loss	.....
Cons. Main Reef	706,200	263,591	7.465	1,118,845	26 6	183,609	5 2	121,234
Crown Mines	2,643,000	856,005	6.478	3,642,194	20 5	946,539	7 2	599,991
Durban Roodepoort Deep	481,300	164,809	6.848	701,129	27 3	46,120	1 11	.....
East Rand Prop. Mines	1,721,500	461,603	5.363	1,964,654	21 3	134,174	1 7	.....
Ferreira Deep (Jan. to May)	133,500	23,832	.....	101,121	.. ..	4,744	.. ..	.....
Geduld Proprietary	1,008,100	318,994	6.329	1,366,386	16 6	534,217	10 7	456,518
Geldenhuis Deep	760,900	176,170	4.631	749,773	18 8	39,894	1 0	28,333
Government Areas	2,416,000	1,086,163	8.991	4,699,629	16 4	2,722,983	22 7	1,260,000
Langlaagte Estate	968,500	313,105	6.466	1,348,550	21 2	324,751	6 8	227,975
Luipaards Vlei	276,600	70,984	5.133	300,155	19 5	31,796	2 3	.....
Meyer and Charlton	203,200	54,527	5.367	233,102	20 8	23,410	2 3	.....
Modder B	836,000	302,724	7.242	1,294,103	17 3	574,048	13 9	560,000
Modder Deep Levels	531,500	280,665	10.561	1,195,849	15 8	778,643	29 4	675,000
Modder East	804,000	243,422	6.055	1,040,797	20 6	218,195	5 5	186,161
New Kleinfontein	617,300	135,358	4.385	574,631	18 3	11,750	0 4	.....
New Modderfontein	1,767,000	873,294	9.884	3,725,580	17 3	2,200,353	24 11	1,960,000
New State Areas	918,000	391,430	8.528	1,683,036	20 10	725,842	15 10	189,255
Nourse Mines	728,100	210,757	5.789	897,037	23 1	55,985	1 7	19,592
Randfontein Estates	2,528,000	595,249	4.709	2,563,234	18 2	269,066	2 1	.....
Robinson Deep	919,900	253,147	5.504	1,073,621	19 7	174,049	3 9	75,000
Rose Deep	690,100	143,556	4.160	610,880	16 8	35,048	1 0	.....
Simmer & Jack	895,100	224,796	5.023	952,621	19 8	71,950	1 7	.....
Springs Mines	825,600	398,965	9.665	1,691,864	22 4	771,370	18 8	543,750
Van Ryn Estate	472,900	112,870	4.774	483,663	18 1	54,780	2 4	25,000
Van Ryn Deep	748,000	294,009	7.885	1,267,378	20 2	512,246	13 8	418,912
Village Deep	699,500	184,292	5.269	783,629	20 9	59,146	1 8	50,006
West Rand Cons	1,043,300	266,116	5.101	1,141,554	18 0	200,902	3 10	.....
West Springs	763,500	221,895	5.813	940,038	18 3	243,430	6 4	179,300
Witwatersrand	641,000	134,984	4.212	594,043	17 5	34,124	1 1	11,741
Witwatersrand Deep	513,200	113,714	4.432	481,838	19 6	19,059	0 9 Loss	.....
Wolhuter (Jan. to May)	130,700	29,967	.....	127,332	.. ..	3,560	.. ..	.....
Miscellaneous Producers	.....	83,959	.....	.....	.. ..	.....	.. ..	.....
Totals—Witwatersrand and averages	30,502,800	9,980,713	6.489	£42,297,268	19s. 7d.	£12,477,732	8 2	£8,085,018
Glynn s Lydenburg	74,600	24,594	6.594	104,400	25 10	7,996	2 2	.....
Sub Nigel	294,500	252,608	17.155	1,070,752	45 8	398,545	27 1	300,000
Trans. G.M. Estates	172,600	57,988	6.719	246,729	25 10	23,918	2 9	28,598
Miscellaneous producers	.....	98,163	.....	.....	.. ..	.....	.. ..	.....
Totals and averages—outside districts	541,700	433,353	12.375	£1,421,881	36s. 7d.	430,459	15s. 11d.	328,598
Totals and averages—Transvaal	31,044,500	10,414,066	6.592	£43,719,149	19s. 10d.	£12,908,191	8s. 4d.	£8,413,616

New Conveying Practice at the Bunker Hill Smelter

A. F. Beasley
Smelter Superintendent



Vibrator conveyor, under full load, discharging into surge bin, at right. Special dust-proof hoppers are seen above the conveyor. Absence of dust and steam is evident.

REDESIGN of handling equipment effects a notable reduction of dust loss in moving pre-roasted material from Dwight & Lloyd sintering machines

IN THE COURSE of continuous search for unaccountable losses, which work is always in progress at all smelters, one loss of this character was recently investigated at the Bunker Hill smelter of the Bunker Hill & Sullivan Mining & Concentrating Company, at Kellogg, Idaho, with some rather new and interesting developments. The loss here referred to occurred in handling the pre-roast, from the time it was discharged from the sintering machines until it was delivered to the mixing bins. I believe all pyrometallurgists will agree with me that mechanical dust losses have increased since the advent of flotation concentrates, double roasting over Dwight & Lloyd machines, and the consequent regrinding of the first roast.

Previous to the installation of the present equipment, the handling of this roast from the sintering machines resembled practice elsewhere, in that the pallets, as they were discharged from the Dwight & Lloyd machines, were dropped into a chute, through which the material passed into a car, of either the open-gondola or modified mine-car type. After the required tonnage had been placed in the car, the switch crew removed the car, replacing it with another empty car. The loaded car was then taken to the crushing plant, where the contents were prepared for the mixing bins; there the car was emptied by opening the bottom doors, and the roast dumped into a bin under the track.

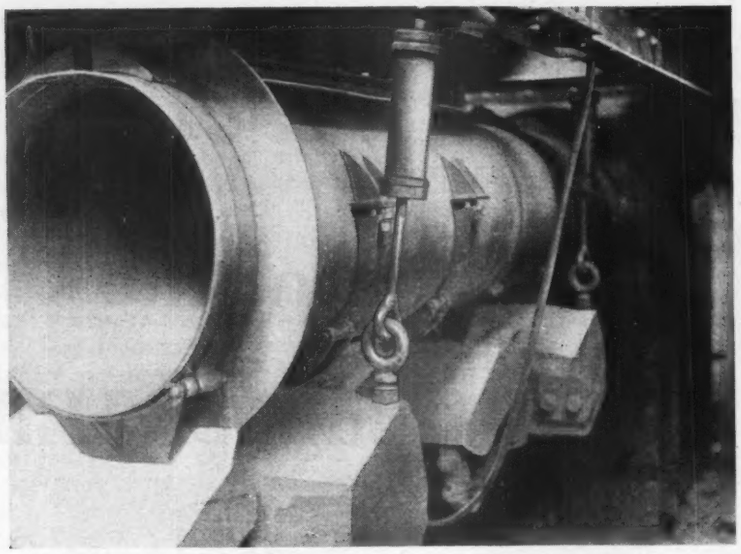
Investigation of this rather prosaic method of operation showed that it involved losses in the form of dust and spillage, but more particularly in the amount of material taken off in the steam. Each time the pallet was spilled into the chute, and when the pallet hit the bottom of the car, a cloud of dust and steam arose, resulting in a part of the valuable constituents of the material being dissipated into the air. This also occurred when the car was dumped. Moreover, besides being objectionable under certain weather conditions, the method was also a serious menace to the health of the men.

With the preliminary investigation completed, redesign of the plant and selection of equipment to handle this material in an entirely dustproof circuit was undertaken. The accompanying flow sheet shows the arrangement finally adopted.

Special discharge hoppers from the Dwight & Lloyd machines, meeting the following requirements, were designed: (1) They had to be substantially dust-tight; (2) they were to be so arranged that sinter under emergency conditions could, by opening a gate, be discharged into cars; (3) the chimneys over the end of the Dwight & Lloyd machines were to be rebuilt so that they connected tightly with the special discharge hoppers; the tops were to be connected to a common gathering flue, on the end of which was to be a large dust-settling and steam-condensing chamber; on the top of this chamber was to be a short stack for natural draft.

After a thorough investigation of all types of mechanical conveyors, the Traylor vibrator conveyor, tubular type, was selected for gathering and conveying the roast from the five Dwight & Lloyd machines used in the pre-roasting operation. The selection was made following a six-months' trial of one section of this type of conveyor operating on roaster No. 1.

The five Dwight & Lloyd machines under consideration are spaced 16 ft. apart on centers, and 80 ft. of conveyor is therefore required for the gathering operation. This conveyor is made in



Vibrator conveyor installation beneath screw crusher

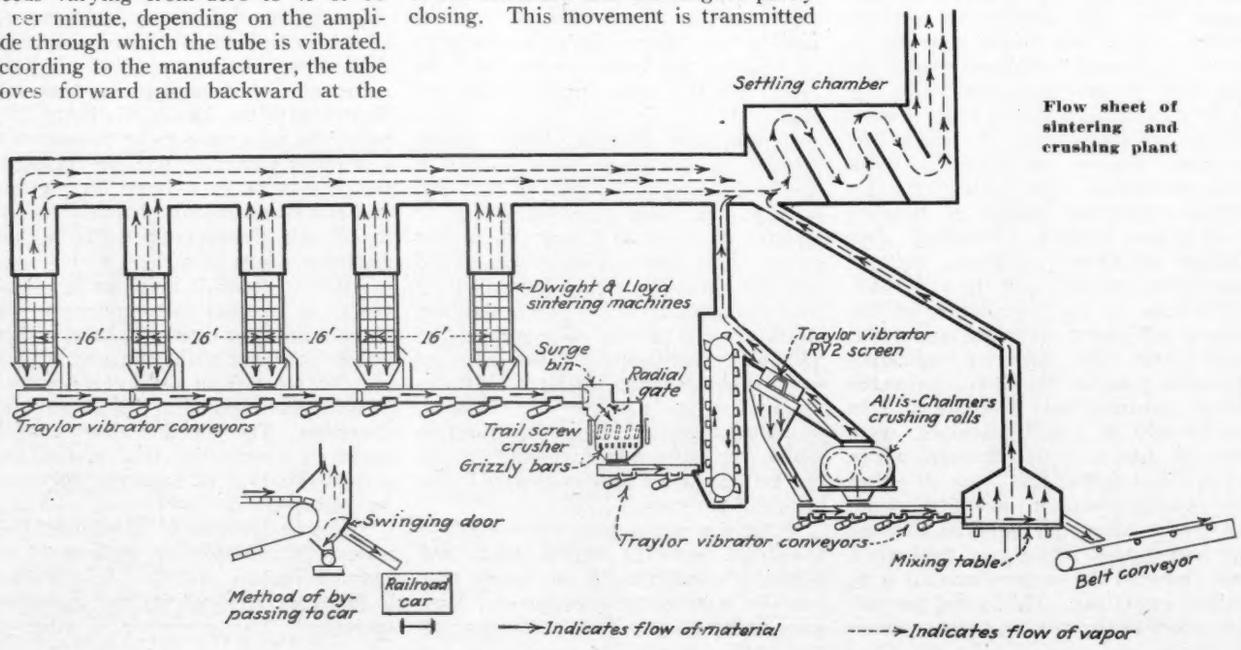
three sections: two 32 ft. long and one 16 ft., so arranged that each section discharges into the succeeding section. One of the two 32-ft. sections serves roasters Nos. 1 and 2, the other serving roasters Nos. 3 and 4; the 16-ft. section serves roaster No. 5. The direction of conveying is from roaster No. 5 toward roaster No. 1. These conveyor units, designated as Type CVS6 by the manufacturer, are 26-in. diameter tubes, onto which vibrating mechanisms have been clamped. The vibrating mechanisms cause the tube to oscillate along its axis at the rate of 3,600 vibrations per minute, the strokes seldom exceeding $\frac{1}{16}$ in. in length. Vibration is imparted at an angle to the axis, so that, as the tube moves forward in the direction of conveying, it also moves upward, and, as it moves backward, it also moves downward. This causes the material inside the tube to travel along its length at speeds varying from zero to 45 or 50 ft. per minute, depending on the amplitude through which the tube is vibrated. According to the manufacturer, the tube moves forward and backward at the same speed, and conveying is, therefore, not the result of what is commonly known as "differential" or "quick return" motion.

A heavy cast-iron main frame, rectangular in cross-section and about 54 in. long, holds the vibrator units. In the frame is a rectangular hole filled with vibrator bars which are rigidly clamped to the frame at each end by setscrews. At the center they are also clamped by a steel casting which is strapped to the tube. The resultant arrangement resembles a multi-leaf spring, so assembled that the bars may flex backward and forward across their normal positions of rest. This flexing causes the tube to move backward and forward. A laminated armature, with a *C*-shaped stator, is attached to one end of the center steel casting. When the current is applied, the stator attracts the armature, the gap between the face of the armature and the magnet partly closing. This movement is transmitted by the steel casting to the bars, causing them to flex. When the supply of current is cut off or reversed, the bars, having been flexed toward the stator beyond their neutral point, spring back and pass the neutral point in the opposite direction. Power is then applied again to the stator, and the armature is attracted, causing the bars to flex again. This operation takes place 3,600 times per minute, as 60-cycle current is employed. The total assembly might, therefore, be described as a synchronous motor of oscillation rather than of rotation. Four of these vibrator units are attached to each 32-ft. section of the 26-in. tube, and two to each 16-ft. section.

The conveyor meets a number of rather interesting requirements: no oiling or greasing is necessary; it has no bearings or movable parts, which is a decided asset in the application of the device at a smelting plant; and it is entirely electrical in its operation. Operating power at 440 volts is obtained through a transformer from 2,300-volt 3-phase service lines. With the equipment, the manufacturer supplies a small motor-generator set which is so arranged that, by means of a rheostat, the speed of conveying through the tube may be varied at will.

Each of the special dust-proof discharge hoppers from the Dwight & Lloyd machines has a 16x42-in. opening, the long dimension being parallel to the axis of the tubular conveyor. In the top of the conveyor, and directly under the hopper opening, is an opening of the same size, the space between the two openings being closed by heavy packing. A light channel-iron framework supports the conveyor, which is hung on special shock absorbers to protect it from the vibration of the building.

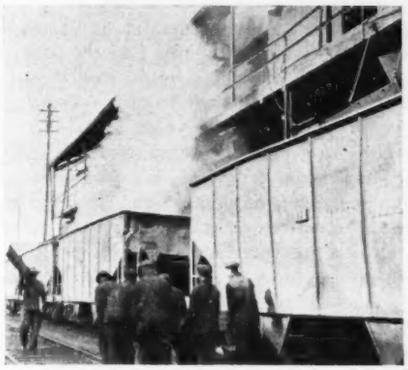
At the end of the gathering conveyor,



Flow sheet of sintering and crushing plant

which is made up of three sections of 26-in. diameter tubing, is a small surge bin, mounted directly over a screw crusher. This surge bin distributes the feed to the crusher. It is equipped with a radial gate at the bottom, so that the feed to the crusher may be instantly shut off for short periods, during which the roasters are not shut down, the feed accumulating in the bin.

The screw crusher, which was developed at the Consolidated Mining & Smelting Company's smelter, at Trail, B. C., has long been used at the Bunker Hill smelter with satisfactory results. It consists primarily of a rectangular



Dust and steam conditions involved in former handling methods

cast-iron box, the bottom of which is made of grizzly bars. The tops of the grizzly bars are set on a radius from the center of the shaft on which the screw flight is carried and are parallel to the axis of the shaft. A grizzly grate is also used at the end of the screw flight. The shaft on which the flight is mounted is so arranged on the rear of the crusher that the large flywheel employed gives the flight sufficient inertia to handle peak loads and hard pieces of sinter. In the front or driving end of the shaft is a safety shear pin which is sheared off without damage to the flight or to the machine whenever anything of a non-crushable nature enters the crusher. The grizzly bars at the bottom are set at about 2-in. openings, and the grizzly bars at the end are set closer than this. The machine has ample reserve capacity to cope with heavy surges of feed that occur at times, for example when the pallet from No. 5 roaster arrives under No. 4 roaster just as the pallet from the latter is dropped, then these two pallets arrive under No. 3 roaster as it discharges, and so on until five pallets comprise the surge. These conditions necessitate the use of a flexible crushing device with ample capacity.

Directly beneath the screw crusher, another Traylor vibrator conveyor is mounted; this is a tube 20 in. in diameter, made of 10-gage steel, and is operated by a smaller and lighter type of vibrator. The unit is designated by the manufacturer as Type CVS5. This conveyor moves the discharge from the screw crusher 10 ft. horizontally to the boot of a chain elevator, where it is elevated about 40 ft. and discharged through a chute onto a Type RV2 Traylor vibrating screen, with $\frac{5}{8}$-in. openings. Oversize from the screen passes to a set of Allis-Chalmers rolls. The undersize and roll product enter another Traylor vibrator conveyor, Type CVS5, with a 20-in. diameter tube, 20 ft. 8 in. long. This is so mounted that the undersize product from the screen passes from a chute into the rear end of the conveyor and the discharge from the rolls enters the conveyor at about the middle of its length. The total feed is then conveyed onto a mixing table.

All of the equipment described — namely, the screw crusher and the conveyor under it, the chain elevator, screen, rolls, and the conveyor under the rolls—is inclosed and dust-tight. The dust liberated at this equipment is drawn off through a short stack, at the top of the elevator, into a dust-settling and steam-condensing chamber. This chamber, in turn, has a short stack affording natural draft.

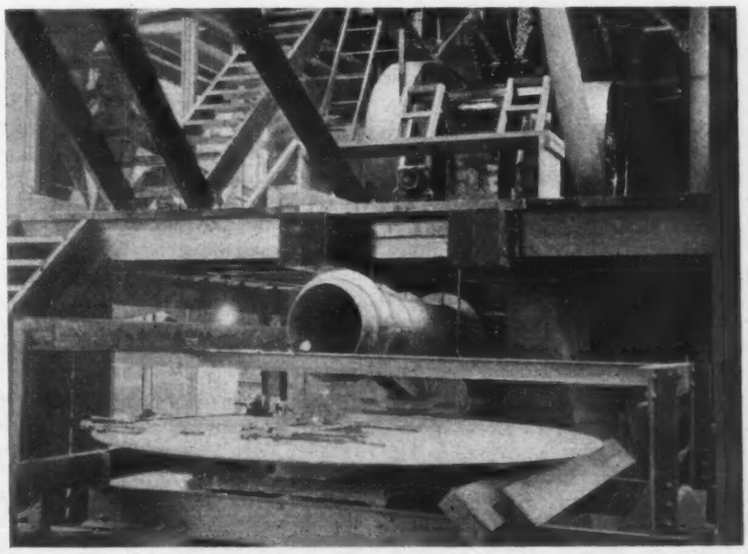
As the mixing table revolves, the feed is gradually worked out to its edge, the material meanwhile continuously passing under fine, mist-like sprays. As it leaves the table, the material, in a cool and damp condition, passes onto a 20-in. belt conveyor. Inclosing the mixing table is a dust-tight hood which is connected to another dust-settling and steam-condensing chamber, equipped with a short stack for natural draft. In the settling and steam-condensing chambers, the dust is settled as a mud which passes through chutes into the circuit again at the mixing table. By this procedure the fines, which heretofore were dissipated into the air, are now recovered and mixed with the coarser particles for subsequent treatment. From the mixing table the material is transported 300 ft. on the 20-in. conveyor belt to the building in which the mixing bins are situated.

The system, as arranged, simplifies operation procedure, besides facilitating inspection and protecting the health of the workers. All the apparatus is electrically interconnected, so that the failure of any piece of equipment in the system sounds an alarm. Workers on the lower levels keep in close communication with those on the sintering floor by means of electric signals, so that variations in the feed or shutdowns are instantly communicated from one group to the other. Even when in full operation, the plant is remarkably quiet; it requires a minimum of service and attention; and is largely automatic in operation.

Here at the Bunker Hill plant, we of the operating staff are quite proud of the fact that we were the first smelter to utilize the advantages offered by the vibrator type of conveyor. We feel these conveyors can be applied widely, and we recommend them highly for the handling of hot or dusty material. By this method of handling the roast, results to date indicate savings in excess of those anticipated.

An analysis of an average sample of dust recovered from the settling boxes follows:

Silver, 21.0 oz. per ton; lead, 52.6 per cent; iron, 8.8 per cent; insoluble, 7.1 per cent; calcium oxide, 2.4 per cent; sulphur, 12.7 per cent; zinc, 6.4 per cent. About 99.4 per cent of the collected dust passes a 250-mesh screen.



Construction view of vibrator conveyor between rolls and revolving mixing table

Local Factors Affecting Technology in the

Northern Rhodesia Copper Belt

C. Maxwell Norman

SO MUCH has been published in the last year on the history, geology, economics, possibilities, and general conditions of the vast new copper field of South Central Africa that the average mining engineer is now passably well informed on these subjects. Matters of technology have not been discussed at such length, however, nor has the probable effect of local conditions on the development of mining and metallurgical practice been given a great deal of attention in the press. The matter of timber supply, for instance, as well as the shape of the orebodies and the character of the ground, will be a factor in the mining methods employed; also, comment on the labor, fuel, communication, and power problems, from one who has first-hand knowledge, may not be amiss.

In Northern Rhodesia the timber question is of vital importance. The country is entirely wooded except for comparatively narrow strips of savannah-like grassland, known as dambos, and usually running along the sides of the many rivers and streams. But the indigenous timber is almost without exception unsuitable for underground timbering. Trees rarely attain a greater diameter at the ground than 24 in., and the average grown tree is considerably smaller. Probably 80 per cent of the total timber is too small for underground purposes, and of the remainder a large proportion is of the extremely hard and heavy "ironwood" variety. So hard does some of this become upon being allowed to season that a buzzsaw will break its teeth on it. The result is that it must be framed and sawn green. This again is quite unsatisfactory, on account of warping, checking, and shrinking afterward. Another point is its excessive weight. Indeed there are many classes of wood of which a 4x3x1-in. block, when polished, will make an excellent paper weight.

This, then, is going to rule out immediately, quite apart from other considerations, any mining method which requires much timbering, such as top-slicing or square-setting, on account of the tremendous addition to the cost per ton of ore mined. Certain of the mines, the Roan Antelope for one, have already set out plantations of a species of eucalyptus with an eye to the future. (N'Changa is a notable exception, for although a forestry survey was made with this end in view, and a favorable report returned, no plantation resulted.) But in spite of heavy planting of seven-year-growth trees, the question of timber will be a decidedly serious one in the future.

In point of fact shrinkage and block-caving will be the two main mining methods employed. Unlike the huge irregular limestone-walled porphyry orebodies of the United States that are at present being caved in the Southwest, the Northern Rhodesian ore horizons are synclinal beds, the dips of which not only vary from 20 to 90 deg. on opposite limbs, but also vary considerably on the same limb at different points along the strike. The actual ore-bearing strata also vary at different mines and on separate limbs of the same syncline at the same mine, even though the general series and geological time of deposition were the same. These copper-bearing sediments vary between argillaceous sandstones, shales, banded shales, and feldspathic quartzites and sandstones, and the thickness of any one bed may be from a mere trace up to 140 ft. The factors enumerated make apparent the fact that the application of almost any known method is in the nature of an experiment, and the work of the more developed mines will be of inestimable advantage to those coming into production a few years later.

The ore crushes satisfactorily, and, as has been observed in old surface dumps, does not pack easily, giving good free-running muck even months after having been broken. On the flatter limbs of the synclines where the copper-bearing solutions, in certain cases, have penetrated the feldspathic quartzites and sandstones rather than the shales, the back caves easily, which is an advantage rather than a disadvantage. In some parts shrinkage is the obviously ideal method; in others it would be difficult to mine the ore by any other method than block caving. These two methods, therefore, will undoubtedly be the outstanding mining methods employed. The ordinary block-caving system as used in the mines of the Southwest of the United States will probably have to be largely modified to fit local conditions, the main point of variance probably being in the method of undercutting. The lift also will be considerably smaller, and special economies will have to be made in ore collection and haulage.

At all the mines hard arkoses and granites are sufficiently near the ore horizons to provide excellent hard rock haulage levels and shafts, though in the actual mineralized sediments development will not be able to go far ahead of extraction, on account of the weakness of the ground. Practice, as it develops, will probably suggest improvements or variations applicable to the lower-grade deposits of other countries.

In these notes, consideration is being taken only of the already established mines. Conjecture concerning probable mining methods to be used on the much higher-grade ore deposits to the northwest and southeast of N'Changa would be futile at this juncture. The grade of the ore (in several instances reaching 25 and 30 per cent) will, in this part of the copper belt, prohibit the application of shrinkage or caving methods. With the difficulties of the timber question in mind, the situation is likely to present an involved problem.

The question of labor in Northern Rhodesia is one that, for all the talking, has not really been given due consideration. In all Northern Rhodesia there is an insufficient indigenous population to cope with the probable demands of the country ten years hence. In spite of the prominence of the mines, and the fact that they are the *sine qua non,* there are what might be termed the parasitical industries, which, of necessity, must follow, in increasing numbers. Besides those, one must consider the requirements of the government, the railroads, and the immense farming possibilities. Especially will this parasitical population grow with the inevitable growth of the cities to be. All this development will call for tremendous quantities of labor, quite apart from the requirements of the mines.

On the other hand, with every year that goes by the native becomes more and more educated, and where it might take four "boys" to accomplish a certain piece of work in a given time at present, in ten years' time an equal amount of work might be accomplished by only two, thereby releasing two for other work. However, even including this possibility, there will undoubtedly be a lack of native labor. What, then, is going to be the solution? Two courses are open:

1. Immigration of the native.
2. Immigration of the white man.

As regards the first it must be remembered that the Belgian Congo is already recruiting large native forces from outside its own territory to cope with its own ever-increasing demands. Southern Rhodesia and Northern Rhodesia are already doing the same, and in spite of the dense population of adjoining Nyassaland, to cause a sufficient native immigration to satisfy future demands seems certain to be impossible.

Coming to the second possibility, the influx of the white man is going to create a serious problem and one that should have careful thought even now. For, if native labor is insufficient, certain white men, if they are to be the solution, will have to do the same work as the natives, and although the native will do this work for a song, the white man will demand a "living wage." Evidence is even now at hand that the substitution of native drivers for white men on motor trucks and tractors will arouse a feeling against the natives among the white men who have hitherto been earning their living by such pursuits.

Here, then, is a problem in economics that will require not only careful handling, but one which demands great forethought and immediate consideration, and the operative companies in the Northern Rhodesia copper belt should lose no time in making a survey of the question in minute detail.

In one particular these new mines will have a great advantage over other mining districts in the world. Science and invention as applied to mining have made their most phenomenally rapid strides in the last twenty years, and whereas the older mining fields have, in a large measure, been the experimental laboratories of these new discoveries, the sudden and amazingly rapid development of the Northern Rhodesia mines makes it possible for the latter to take immediate advantage without the burdensome cost of experiment, scrapping of unsuccessful ideas and plant, more experiment, and so on. Indeed, it is already evidenced that these mines will take the fullest advantage possible of everything that modern science offers. Especially is this true in the substitution of machinery for hand labor, where the latter, for all its cheapness, is so extraordinarily costly.

As an instance of this policy, I may mention the adoption of radio communication. At N'Changa, N'Kana, Bwana M'Kubwa, N'Dola, and Broken Hill (the last named is the headquarters of the Rhodesian Anglo-American Corporation) full-time radio operators are employed. The equipment was originally home-made by amateurs, as an experiment, under the auspices of the Rhodesian Anglo-American Corporation, but such amazing success was attained that it soon passed out of the amateurs' hands into those of the present paid operators. All telegrams, cables, and much of the important correspondence has been handled by this means, and frequent consultation between managers and consulting engineers has been made possible. High frequency has been used (7,000 and 14,000 kilocycles) and both radio-telegraphic and radio-telephonic communication is a daily occurrence. The object, of course, was to circumvent the almost prohibitive initial and upkeep cost of land telephone and telegraph lines through the immense forest-covered areas, and it has undoubtedly proved an enormous success.

The position of the American in this British colony is interesting. As in the early days of the Rand, most of the mine managers are Americans. But whereas on the gold mines of the Rand the American managers (I am not individualizing but speaking in broad generalities) made themselves decidedly unpopular and caused much ill-feeling, the Americans at present in the copper belt are, on the whole, making serious efforts to make their presence agreeable. There is neither ill-feeling nor antagonism at most of the properties, and the reasons for this are not far to seek. First, these Americans, being in Rome, are emulating the Romans. This is a popular gesture for a minority in any country. And, second, the average Britisher inherently desires fair play, and he realizes that it is only the mining engineer with experience in the United States, and particularly in the Southwest, that has the requisite knowledge of similar copper-mining conditions. Indeed, where the Americans at present in Northern Rhodesia are sincerely endeavoring (against their general reputation and much precedence) to fall in with local conditions and customs, nothing but amity is apparent in Anglo-American relations. Only when an American continually and verbally suggests that the United States is a much finer country—and such instances are extremely rare, though decidedly existent—is there any feeling of discord. Northern Rhodesia is essentially democratic—more so, perhaps, than any other British colony, though none the less patriotic, and the present local friendship between British and Americans augurs well for the future of a country whose development will involve capital investment by both countries.

Fuel and power constitute a problem that is being seriously considered at most of the mines. So far, power has been basically steam, generated by wood fuel chiefly in water-tube boilers; and electricity and compressed air have been dependent on this. Operators, however, naturally realized long ago that this was costly and only a temporary measure to be used during preliminary work. The two alternatives are coal-generated steam and hydro-electric power. As regards the first, the Wankie colliery can provide an excellent coal at cheap cost as soon as the railways at present under construction to the various mines are completed. Then there are the possibilities of the untouched Luano coal field, to the southeast, which, however, has yet to be proved and is at present as useless as a mirage.

Hydro-electric installations are the real solution, and here ample opportunities exist. The Victoria Falls are only between 370 and 400 miles from all the existing mines in the copper belt. But there is the difficulty that many years ago certain colliery interests further south floated a subsidiary company, the Victoria Falls Light & Power Company, Limited, and managed to obtain a concession of all water and power rights over a circular area 10 miles in diameter with the falls as the center. Nothing, of course, has so far been done to exploit this vast source of cheap power, the whole object presumably being to prevent its utilization in favor of developing the coal field. With such a market, however, as the copper belt now provides, it should not be long before serious plans for a hydro-electric installation on the Zambesi River at this point are considered.

Apart from the Victoria Falls, many other sources of cheap hydro-electric power are as yet unsurveyed. There are the Balengwe Gorge, the Gonye Falls, the Kariba Gorge, the Kabompo Gorge, and so on, all considerably nearer the center of the copper belt than are the Victoria Falls. Some of these have

been photographically surveyed from the air (as has most of the Zambesi River where it lies in Northern Rhodesia, and part of the Kabompo and Lungwebungu rivers). Besides these, there are small waterfalls in the immediate vicinity of the mines themselves that could easily be made to supply moderate amounts of cheap power. As an example of these may be mentioned the Lumangwa Falls, on the Kafue River only 3 miles from N'Changa mine, which would give more than 600 hp. even in the dry season.

Taking all these facts into consideration, that the near future will see the establishment of huge hydro-electric plants appears certain, and, indeed, plans for such development are already all but under way.

In conclusion, one other thing should be mentioned: The average visitor to the copper belt has been far too likely to make a hurried tour of the important centers—N'Dola, Bwana, Roan Antelope, N'Kana, Mufulira, Chambishi, and N'Changa, spending a few hours at each place, and going away feeling that his knowledge of the area is almost complete. Nowhere else in the mining world is this practice noticeable, for the engineer or geologist realizes that many of the real influencing factors cannot be absorbed without intricate inquiry and painstaking study. The result has been that the vast expanse of thousands of square miles of territory in the neighborhood of the copper belt is scarcely noted by the average visitor. And yet, as may well be seen, from the report of the seventh annual general meeting of the Rhodesian Congo Border Concession (held in December), there are almost undreamed-of possibilities not covered by the above-mentioned mining centers. Furthermore, in the N'Kana Concession itself there are such possible potential mines as the occurrences of copper at Mokambo, on the Bwana Syncline; the Kalalushi Syncline (lying to the south of N'Kana Mine), and eighteen other favorable mineralized locations on which drilling programs are at present being carried out.

In spite of this—or, rather, because of it—the errors are, through ignorance, on the conservative side, and intending visitors who wish to obtain an accurate knowledge of existing conditions and possibilities should not neglect the concession companies in their surveys. The excellent idea, originally advocated and adopted in this country, of passing on all possible knowledge concerning a mine, its workings, and its methods, to serious visitors, is practiced throughout the length and breadth of Northern Rhodesia, and methods and ideas concerning systematized prospecting could possibly be gleaned from a careful study of some of the Rhodesian concession companies and applied with surprising results to certain districts in the United States.

Morenci Branch Wins Phelps Dodge Safety Contest

THE safety of workmen is considered a major operating problem at the Morenci Branch of the Phelps Dodge Corporation. The management insists that safety be the first consideration. All plans for new work must be approved for safety before being put into effect. For the past year, studies have been made to establish standard practices on routine work, particularly in the mining division. This division, after a careful survey, compiled a book of "Standard Practices and Instructions," which was issued to the bosses, who are responsible for the safety of their men, as a textbook and guide.

For the new man the safety education begins with the employment agent, who outlines the policy of the company, gives him the rule book, and informs him that he must pass an examination on these rules within thirty days. In the mining department, however, new men are examined before going to work. They are also required to take a course of instructions in first-aid work during the first week of their employment. The employees are encouraged to review their first-aid work by contests held annually. Prizes are given, and the winning team gains the opportunity to compete in the international contest. This work has recently been stimulated by a 100 per cent campaign under the supervision of the U. S. Bureau of Mines.

Workmen's safety committee meetings, attended by bosses and men, are held periodically for the discussion of safe practices. Moving pictures on the subjects of safety and health are stimulating interest in these meetings.

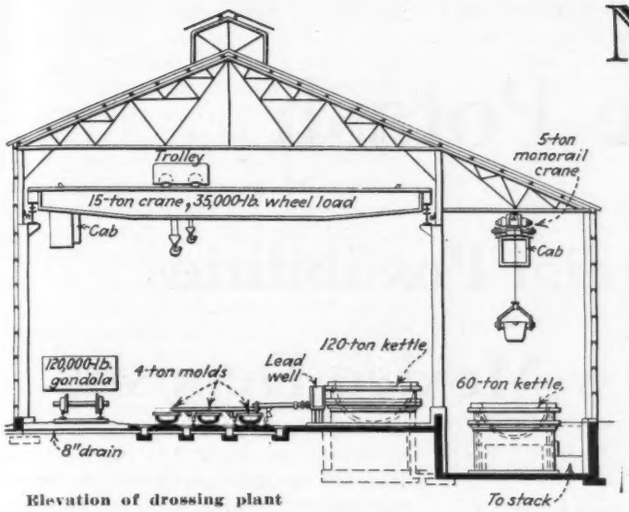
Workmen's inspection committees make periodical inspections and recommendations for the elimination of hazards in practices and equipment. These recommendations, when approved by the superintendent, take precedence over other work. Fire hazards are given particular attention, a full time inspector being employed. The mining staff at regular intervals meets and discusses the handling of underground fires, to prevent loss of life and destruction of property. Local and National Safety Council posters are displayed throughout the plants, and prizes are awarded for the best safety suggestions submitted for the month. Local pictures are displayed showing the safety sequence of jobs with one step missing, and small prizes will be given for the proper solution.

Men are required to wear protective clothing in all departments wherever necessary for protection. All men working in the mine are required to wear safety hats and safety shoes, and no one, including officials and visitors, is allowed to go below the collar of the shaft without wearing a safety hat. Men on grizzly work are provided with Morenci spats for protection of the instep and Morenci safety belts to prevent falling through the grizzlies. The safety belt is also worn by men working on shaft and chute repairs, scaffolds, and any other place where there is danger of falling. Goggles are required to be worn in all departments on work where eye protection is necessary. At the smelter and foundry, fireproof clothing is provided for protection against burns. Last, but not least, good housekeeping is emphasized in the safety program of the Morenci Branch.

With so well organized a program, and with the keen co-operation of executives and workmen, it is not surprising that the Morenci Branch has just completed the best year in accident prevention of its existence, winning five of the seven trophies given by the Corporation for the best safety record. It retains the James Douglas Memorial Safety Trophy won in 1928, having only six lost-time accidents for the year 1929. This trophy is awarded to the company having the lowest frequency rate, the Morenci Branch having a rate of 0.013 accidents per 1,000 shifts worked. The banner for the lowest severity rate was also won by Morenci, the rate being 0.272.

Of the departmental trophies, Morenci won three, one of these bronze trophies being obtained by the mining department, with a record of only three lost-time accidents for the year, a rate of 0.016 per 1,000 shifts worked. The concentrating department won the trophy for this division with a clear record for the year. Its best record to date is one year and 92 days, with 86,317 man-shifts. The smelter won the trophy of that division, with only one lost-time accident for the year, or 0.017 accidents per 1,000 shifts worked. This accident terminated a record of two years and 136 days, or 146,473 man-shifts worked without a lost-time accident. The mechanical and surface departments had one lost-time accident each for the year, which, in the mechanical department, ended a record of one year and 320 days, or 123,170 man-shifts, without a lost-time accident. The surface department had operated two years and 32 days, or 71,137 shifts, without a lost-time accident.

New Drossing Plant



Elevation of drossing plant

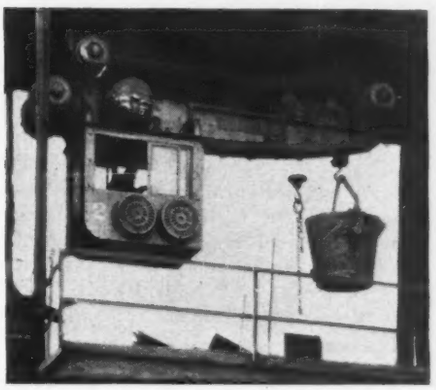
John B. Huttl

INTERNATIONAL SMELTING, at Tooele, Utah, Achieves Safety and Economy by Use of Modern Hoisting and Conveying Machinery

INSTALLATION of modern hoisting and conveying machinery at the new drossing plant of the International Smelting Company at Tooele, Utah, has resulted in lower operating costs and safer working conditions. The new building, a steel-frame structure, in which the lead bullion is drossed, cast, and loaded, is adjacent to the blast furnaces. Four 60-ton and two 120-ton cast-iron, coal-fired drossing kettles are controlled from an elevated platform. The transportation of the molten lead from the blast furnace to the drossing kettle, through a well-planned overhead monorail system, an operation formerly performed by hand labor, is the outstanding feature of the new plant.

As shown in the accompanying illustrations, the monorail, supported by angle-iron trestles and girders, and three 15-ft. switches intimately link together the five blast furnaces and the drossing department. An electric-operated Telpher traveling crane of five tons' hoisting capacity, with its bail ladle, assures the safe and efficient transportation of molten lead from the furnaces to the drossing kettles, and of dross to the furnaces, at minimum cost and loss of time.

Transfer of molten lead from the 60-ton to the 120-ton kettles is effected through electrically driven vertical centrifugal lead pumps—which operation assures greater safety to the men concerned and avoids costly spills. The equipment of the casting department, situated on the lower floor of the building, consists of a lead well, with its connected movable filling pipe, and several cast-iron molds arranged in a semicircle around the well. The work of casting and marking the bullion is performed manually.

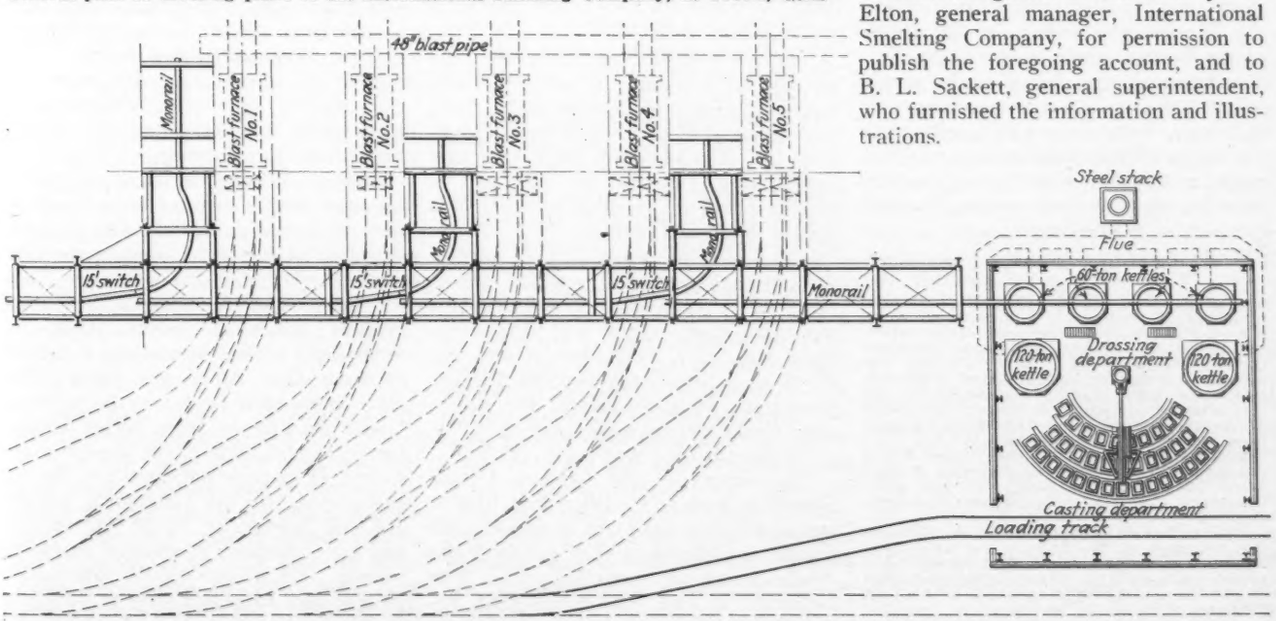


Five-ton monorail crane

Considerable labor economy has also been effected by the installation of a 15-ton overhead traveling crane. Bullion ingots each weighing four tons, a weight which renders them safe from theft, are now being cast and loaded with this crane on flat railroad cars. Formerly, small bars were loaded by hand labor into closed and sealed box cars.

Acknowledgment is made to J. O. Elton, general manager, International Smelting Company, for permission to publish the foregoing account, and to B. L. Sackett, general superintendent, who furnished the information and illustrations.

General plan of drossing plant of the International Smelting Company, at Tooele, Utah



Domestic Potash

Present Commercial Possibilities of the Texas and New Mexico Deposits

James S. Wroth

CERTAIN factors in the general potash situation have led to active investigations by the government in this field, including both economic surveys and studies and technical and scientific research. These preliminary investigations culminated in the appropriation of government funds for drilling the salt beds of Texas and New Mexico, and may be listed as follows:

1. Potash is essential to industry and indispensable in agriculture.

2. The United States depends upon foreign sources for the greater part of its potash supplies. For the six years from 1923 to 1928, inclusive, 88.2 per cent of American consumption was derived from foreign sources.

3. Foreign supplies of potash are under monopolistic control regulated by foreign governments. Before the World War this monopoly was vested in the German Potash Syndicate, which in 1910 came under the direct control of the Imperial German government. This monopoly was threatened by cession of the Alsatian mines to France, but was restored by the Franco-German agreements of 1924, 1925, and 1926, to which the French government, as the owner of the French mines, was a party.

4. Monopolistic control of the potash industry by the German syndicate and the later Franco-German combination has enabled these producers to maintain prices at a higher level than might have been enjoyed by the consumer under competitive conditions.

5. The war-time growth of the American potash industry and its collapse in competition with cheaper foreign potash after the war emphasized the necessity of developing a cheap natural source of domestic potash.

6. Discovery of potash minerals during the drilling of oil wells in the salt deposits of the Texas-New Mexico area and careful study of the results of such drilling for some years by the U. S. Geological Survey gradually led to the belief that in this area potash deposits existed that were comparable to the foreign deposits in character and richness. The evidence obtainable from oil-well sludges, though favorable, was inconclusive, and core drilling was recommended.

7. In spite of the favorable indications in the Texas-New Mexico salt beds, private capital was reluctant to enter this field, feeling that evidence of the occurrence of large deposits was inconclusive and that the promise of success was too uncertain to warrant the large expenditures required.

The government was then the only agency left to obtain the conclusive evidence necessary to determine the value and importance of these potash deposits and the possibility of their economic exploitation. It was felt that private capital could be induced to enter this field if this investigation proved successful, and that the possibility of success was favorable enough and the importance of developing a domestic source of cheap potash so great that the government was fully warranted in entering the field of potash development and exploration. In consequence, the necessary funds were appropriated in 1926, and active drilling was begun in 1927.

The history of the German Potash Syndicate leads to the belief that American consumers have not obtained their potash as cheaply as they might if the syndicate had not controlled prices. The syndicate, in fact, has consistently endeavored to maintain prices at levels that assured profits even to its least efficient members. These artificial price levels have been a constant inducement for the development of independent mines that could operate and show handsome profits at lower prices. Since its inception the syndicate's principal difficulties have come from price wars with these independent properties, which, unrestricted as to output, threatened to capture the syndicate's markets by lowering prices.

Thus a certain cycle of events is found recurring repeatedly in the history of the German syndicate and is, briefly, the growth of strong independent competition and resultant lowering of prices, followed by the absorption of the independent properties into the syndicate and the raising of prices to their former levels.

Growth and Collapse of Domestic Production—From 1910 to 1914 consumption of potash in the United States averaged approximately 270,000 tons, practically all of which came from Germany. The passage of the German potash law of 1910 and the ensuing controversy over prices led to appropriation by Congress in 1911 of funds for a study of American potash resources. Investigations were undertaken by the U. S. Geological Survey and the Bureau of Soils, and by 1914 virtually every potential source of potash in the United States had been studied.

During 1914 curtailment of potash supplies from Germany as a result of the war began to be felt, and complete cessation of imports following the German export embargo of January, 1915, created an acute shortage in the United States. Prices jumped to almost ten times their normal levels, and it became apparent that Americans must either make their own potash or do without. Under the stimulus of an active demand for potash at high prices almost every source of potash indicated by the investigations of the Geological Survey and the Bureau of Soils was utilized and the American production increased rapidly. From practically nothing in 1914 it rose to 54,803 tons of potash in

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Abstract from Bulletin 316, U. S. Bureau of Mines. The Bureau wishes to acknowledge the generous co-operation of the representatives of various equipment-manufacturing concerns who have studied the problems of mining and treating polyhalite and have made valuable suggestions and estimates of equipment and operating costs. Those whose suggestions and estimates have been especially valuable include The Dorr Company, Chicago, Ill.; the Oliver Filter Company, New York; the Swenson Evaporator Company, New York; and the Allis-Chalmers Company, New York and Milwaukee.

The author is indebted to J. F. Barkley, fuel engineer of the Bureau, for assistance in preparing the estimate of power and steam costs and to various other members of the Bureau staff for valuable advice and criticism.

1918, about one-fifth of our normal requirements.

When the war ended, in 1918, the prospect of large imports of foreign potash at normal prices checked the buying of high-priced domestic potash, and many plants were closed in 1919. As imports of foreign potash failed to arrive in expected amounts, and as prices remained firm during 1919 and 1920, at about three times their normal level, some American producers continued to operate during those years. The end of 1920 marked the beginning of the world-wide business and agricultural depression that culminated in 1921. The fertilizer business was particularly disorganized, and this, with the arrival of large amounts of European potash at less than pre-war prices and the cancellation of contracts with American producers, combined to put an end to the greater part of the American war-time industry. A vestige of this war-time industry managed to survive the post-war depression and to persist in the face of the competition from European imports. The recovery of potash as a byproduct from the wastes of other industries has continued, but aside from this only one plant obtaining potash from natural sources and having potash as its principal product has managed to survive. This is the plant of the American Potash & Chemical Corporation, producing potash and borax from the brine of Searles Lake, in California. This company and the United States Industrial Chemical Company, of Baltimore, obtaining potash from molasses distillery wastes, account for practically all the present American production of potash.

Table I gives the statistics of production from 1915 to date.

The decline in the American production of potash after the high point in 1918 is due to the single fact that, with the exception of the few concerns that have succeeded in surviving, the cost of producing potash from the various sources that were utilized was higher than the prices at which foreign potash was offered.

The possibility of producing cheap American potash from the greater part of the resources utilized during the war period is very remote. They have been given a fair trial on an operating scale. If potash is to be produced from domestic sources in sufficient quantity to supply American requirements, a cheaper source of potash must be found or more efficient extraction methods developed.

Texas-New Mexico Potash Possibilities—Developments in the Texas-New Mexico salt beds gave some promise that these deposits might supply the cheap natural source desired and indicated that this area justified careful investigation with that end in view. That large areas in Texas and New Mexico were underlain by thick deposits of common salt was well known, but not until 1912 was the presence of potash salts in association with the salt beds discovered. In that year potash was found in the brine from a well drilled near Amarillo, Tex. Since then this Texas-New Mexico area has been the scene of an extensive oil development, in the course of which hundreds of wells were drilled. The Geological Survey, in addition to making a detailed study of the geology and extent of the salt beds, has carefully watched the results of the oil-well drilling. In consequence, potash was detected in the cuttings from many oil wells. The potash mineral polyhalite was identified and its occurrence over a large area in Texas and New Mexico definitely proved.

Table I—Potash Produced and Sold in the United States, 1915-1928(a)

Year	Number of Producers—Total	Number of Producers—Exclusive of Producers of Woodash Potash	Production—Crude Potash Sht. Tons	Production—Available Content of Potash Sht. Tons
1915	5	5	4,374	1,090
1916	70	25	35,739	9,720
1917	95	46	126,961	32,573
1918	128	77	207,686	54,803
1919	102	67	116,634	32,474
1920	66	49	166,834	48,077
1921	20	19	25,485	10,171
1922	12	12	25,176	11,714
1923	12	12	39,029	20,215
1924	12	12	43,734	22,903
1925	9	9	51,565	25,448
1926	7	7	46,324	23,366
1927	9	6	76,819	43,510
1928	9	5	104,129	60,380

(a) Mineral Resources of the United States, from chapter on "Potash" in Part II, for the years shown. From 1915-1923 this information was published by the U. S. Geological Survey and since that date it has been published by the Bureau of Mines.

The only disappointing feature of the Texas developments was the inconclusive nature of the evidence. Such evidence as was obtainable was very favorable. Some of the potash samples were very rich. The geological features of the Texas deposits were similar to those of the French and German potash-bearing salt deposits. Polyhalite is one of the minor potash minerals found in Germany; and, although it is not utilized there as a source of potash because of its disseminated occurrences, its discovery in Texas was distinctly encouraging.

These favorable inferences were drawn from cuttings and sludges from wells drilled for oil. The presence of potash salts could be determined in these cuttings, but the character, thickness, and grade of the original deposits could not.

The Geological Survey published the results of its investigations, emphasizing its belief in the possibilities of these deposits, and urged oil companies and drillers to prospect the salt beds by core drilling, but although four attempts were made to core drill these deposits before 1924 the wells got into difficulties and failed to reach the salt beds. This experience tended to discourage further core drilling by creating the false impression that core drilling in this area was difficult and expensive, if not impossible.

History of Legislation—The first bill authorizing the government to undertake potash exploration by drilling was introduced in 1924. It provided $500,000 annually for five years to be expended by the Geological Survey and $50,000 annually to be expended by the Bureau of Soils to "determine the location and extent of potash deposits or occurrences in the United States and improved methods of recovering potash therefrom." Its main purpose, as disclosed by the hearing, was to provide for core drilling in the Texas-New Mexico field. Hearings were held, but the bill was never reported out of committee and failed of enactment.

A similar bill was introduced in the Sixty-ninth Congress, Dec. 18, 1925, and was passed by the Senate on April 14, 1926. After a hearing before the House Committee on Mines and Mining it was amended to provide $100,000 a year for five years, to be expended jointly by the Secretary of the Interior and the Secretary of Commerce, and the scope of the proposed investigations was limited to determination of "the location, extent, and mode of occurrence of potash deposits in the United States," together with the necessary laboratory tests, such as analyses. This bill in its amended form was approved by the President on June 25, 1926, and under its provisions the necessary preliminary field work was started in the fall of 1926, and drilling began early in 1927.

This act provided that before drilling operations were undertaken the owners or lessees of lands or mineral rights within a radius of one mile of the proposed drilling site must sign contracts agreeing to reimburse the government for the actual cost of the well, regardless of whether potash was discovered or not. It also provided for government valuation of these lands and mineral rights and stipulated that no drilling should be undertaken until these conditions were agreed to by the owners or lessees of the land in question.

There are no government lands in Texas; and since the landowners of Texas refused to agree to the conditions imposed, drilling sites were selected on the government lands of New Mexico. Here, also, owing to the scattered private lands, such as state school lands, homesteads, and oil permits, the one-mile radius feature rendered the selection of drilling sites difficult. Accordingly, on March 3, 1927, an amendment was approved that omitted this clause and provided for royalty reimbursement to the government if potash or oil were discovered and exploited on the tract leased as a drilling site. The provision relating to oil has hindered somewhat the securing of drilling sites in the oil-producing areas.

The actual carrying out of the provisions of this act was intrusted to the Geological Survey and the Bureau of Mines. Because of its knowledge of the

field the Geological Survey designates the drilling sites. The securing of the necessary leases and the entire supervision of the drilling operations is in the hands of the Bureau of Mines. The drill cores are turned over by the Bureau to the Geological Survey for examination, analysis, and petrographic study, after which the cores are returned to the Bureau for use in technologic experiments on treatment processes.

Exploration by Core Drilling—The deposits of potash salts in western Texas and New Mexico are associated with and form part of the extensive rock-salt formation which underlies that area at depths of from 350 to 1,800 ft. below the present surface.[1] This salt formation, of Permian age, occupies a broad, shallow, synclinal basin and is the residue from the evaporation of a former sea. The formation extends northeasterly across western Oklahoma into central Kansas; but the important potash occurrences seem to be limited to the southern part, probably representing the final large basin to which the mother liquors were progressively confined by evaporation. On its western edge this basin conforms more or less closely to the present course of the Pecos River, and the eastern edge swings northward from Crockett County, Tex., through Regan and Glasscock counties. The final stages of the evaporation of the sea water, which resulted in the deposition of the potash salts, took place in the minor basins and lagoons on the old sea floor. The products of this evaporation are rock salt and anhydrite, with which the potash salts are interbedded in thin layers.

From a mining standpoint the potash beds may be considered as completely inclosed by the firm massive salt formation, a material of sufficient strength to stand exceptionally well in open mine workings and not subject to alteration or decay on exposure to mine air.

The potash beds are practically level. The slight structural gradient of the synclinal basin amounts to only a few feet per mile, which for practical purposes, in mining, may be considered as level. Some local folding may be found, but in general throughout the area under consideration the deposits may be taken as horizontal.

Potash deposits disclosed by the government drilling occur at depths of 350 to 1,950 ft., but for a general estimate 1,200 ft. may be taken as the average.

The salt formation in which the potash deposits occur is overlain by a series of soft shales and sandstones in which thin beds of limestone are also found.

Immediately following the passage of the legislation, drilling sites were selected at the most promising locations in Texas, and leases embodying the provisions of the law were sought covering these sites. As has been stated, the Texas landowners refused to accept the conditions imposed by these leases, and pending the correction of these unsatisfactory provisions by amendment to the original legislation the first drilling was transferred to New Mexico on the public lands owned by the federal government. The first three wells were drilled in New Mexico, and after the amendment was passed the next nine wells were drilled in Texas. Actual drilling was begun in February, 1927, and by June, 1929, twelve wells had been completed. Table II shows the performance to date. The first three wells were cored from the surface, and core losses were mainly in the soft shales of the formations overlying the salt series. Well 4 and all subsequent wells were churn drilled to the top of the salt formation, and coring was confined to the salt series itself.

Results—The results of this drilling have been satisfactory to the extent that occurrences of potash salts have been disclosed at every location drilled. Not all of these occurrences have actual commercial possibilities, but unquestionably some of the deposits revealed by this drilling are of considerable economic importance.

The only potash mineral disclosed by the test wells as occurring in deposits large enough to permit exploitation by mining, should such exploitation prove economically feasible, is polyhalite, a complex sulphate of potash, lime, and magnesia having the composition $2CaSO_4.MgSO_4.K_2SO_4.2H_2O$. The potash ($K_2O$) content of pure polyhalite is 15.6 per cent. With the exception of a small showing of carnallite in Well 12, polyhalite is the only potash mineral found in the wells drilled in Texas, but in New Mexico in Wells 1 and 2 thin seams and small scattered masses of sylvite (KCl), carnallite ($MgSO_4.KCl.3H_2O$), kainite ($KCl.MgCl_2.6H_2O$), and langbeinite ($2MgSO_4.K_2SO_4$) were observed.

All of the above-mentioned minerals occur in the German deposits, but carnallite and kainite, with some low-grade sylvite, are the most important minerals and are the sources of practically all of the German production. Sylvite is the only important potash mineral in the mines of Alsace, and the entire French production is derived from this salt.

The showings of these salts other than polyhalite in the cores from the government's New Mexico wells are too small to have more than scientific interest or to indicate the possibility of discovering larger concentrations by further drilling.

Although polyhalite is the only potash mineral disclosed in the government wells that occurs in deposits of sufficient thickness to permit exploitation by mining, should that be economically feasible, private enterprise has discovered deposits of sylvite in New Mexico in beds thick enough to permit such exploitation.

Probably the potash deposits are not continuous over great areas. Each individual deposit has its limits, representing the extent of the individual lagoon or basin in which final concentration of the residual brines took place.

The results of the drilling seem to indicate that the western edge of the large salt basin is the most promising area for the occurrence of economically important deposits of potash salts, and both government and private wells in this area have found such deposits. Evidently the western margin of the former sea marks the area of the final stages of evaporation; and although minor lagoons and basins in which small concentrations of potash salts occurred may have been scattered over almost the entire area of the old sea, and some of them may have economic importance, the largest concentrations of residual brines and the most important deposits of potash salts occurred in this western area. This narrowing of the possible economic area to the western portions of the salt basin is not discouraging. It still leaves a large area of promising territory to be explored.

Characteristics of Polyhalite—As stated, polyhalite is a sulphate of potash, lime, and magnesia having the chemical formula $2CaSO_4.MgSO_4.K_2SO_4.2H_2O$. Pure polyhalite contains 15.6 per cent K_2O. Physically, it is a dense, fine-grained, practically opaque mineral with a specific gravity of 2.8 and a hardness of 2.5 to 3. Its physical properties are similar to those of a fine-grained, compact, pure limestone, although it is much more brittle. In color, polyhalite is usualiy deep brick red, but this varies through flesh pink to salmon pink and yellow. It also occurs as a pure white mineral.

Polyhalite in contact with water breaks down into its constituents; the sulphates of potash and magnesia go readily into solution, leaving a surface coating of gypsum ($CaSO_4$) on the polyhalite particles that partly protects them from further attack by the solvent

Table II—Record of Core Drilling

Well No.	Location	Total Depth Ft.	In.	Footage Drilled in Overlying Formations Above Salts Depth Ft.	In.	Footage Core Drilled in Salt Formation Depth Ft.	In.
1	New Mexico	1,847	6	779	0	1,068	6
2	New Mexico	1,101	0	330	10	770	2
3	New Mexico	1,501	6	429	8	1,071	10
4	Texas.....	2,098	0	(a) 930	3	1,167	9
5	Texas.....	1,799	2	(a) 1,161	4	637	10
6	Texas.....	1,500	8	(a) 436	8	1,064	0
7	Texas.....	1,230	6	(a) 445	4	785	2
8	Texas.....	1,000	10	(a) 467	10	533	0
9	Texas.....	1,700	0	(a) 1,104	5	595	7
10	Texas.....	1,842	0	(a) 1,233	0	609	0
11	Texas.....	2,070	0	(a) 1,081	3	988	9
12	Texas.....	2,752	6	(a) 1,076	6	1,676	0
		20,443	8	9,476	1	10,967	7

(a) Churn drilled with cable tools; no core required.

[1]Hoots, H. W.: "Geology of a Part of Texas and New Mexico." U. S. Geological Survey Bull. 780, 1926, pp. 33-126. Mansfield, G. R., and Lang, W. B.: "Government Potash Exploration in Texas and New Mexico." New York meeting, A.I.M.E., February, 1929.

and retards the rate of solution. In a large excess of water this gypsum will also be slowly dissolved. The fineness of the material and the relative amount of water used are factors in the rate of solution. Experiments at the New Brunswick (N. J.) station of the Bureau show that, using 4 parts of water to 1 part of polyhalite at ordinary room temperatures (21°C.), the potash minerals will all pass into solution in two to ten days, depending upon the degree of fineness.

Mining of Polyhalite—The rock-salt formation in which the polyhalite deposits occur varies in character from a clean, white, crystalline salt to a very dirty salt containing up to 50 per cent and more of clay shale. The polyhalite, together with thin anhydrite beds and clay seams, is interbedded with the salt.

Deposits of polyhalite occur at depths of 520 to 1,930 ft., and for the estimate of a typical case the depth has been taken, on an average, as 1,200 ft. For such a typical case the formations above the salt formation may be assumed to be about as follows:

0 to 50 ft.—Surface limestone, more or less brecciated with considerable clay in seams. Where the surface formation is not lime it is likely to be loose sand to about 50 ft., followed by lime.

50 to 1,000 ft.—Soft clay shales with thin beds of anhydrite or limestone 3 to 20 ft. thick, aggregating, possibly, 150 ft. in this 950-ft. interval; also one to five beds of sand 3 to 30 ft. thick and aggregating possibly 100 ft. in this 950-ft. interval; about half of this sand will contain water.

1,000 to 1,050 ft.—Interbedded shale and anhydrite.

1,050 to 1,200 ft.—Rock salt with thin anhydrite beds and clay seams; in this salt formation the polyhalite is found in flat beds which may be near the top of the salt series or well within it.

Cost estimates are based on a thickness of 6 ft. of polyhalite. Evidence given by the drill cores indicates that the polyhalite can be mined cleanly. The boundaries between the polyhalite and the salt and anhydrite are usually sharp, well-defined bedding planes. The polyhalite usually rests on a thin shale parting and is overlain with salt or anhydrite. At the top it sometimes changes gradually to salt or anhydrite, but this gradual change is not as common as a sharp, clean boundary. Some of the barren roof material will be broken with the polyhalite, but with care in blasting the amount will be small and dilution from this source will not exceed 10 per cent, if that much.

Mining Methods—A large number of fairly well-standardized methods of mining flat-bedded deposits are applicable to mining these polyhalite beds. With such wide choice, the details of the particular method to be adopted in any given case will be determined by the circumstances of the individual deposit and the experience of those in charge. Probably some system of regular rooms and pillars or of open stopes with scattered pillars, leaving just enough pillars and props to support the roof, will be chosen.

Any estimate presented here must necessarily be of a general nature rather than based on a particular deposit fully explored by drilling. However, in order that such a general estimate may present probable costs with a reasonable degree of accuracy, it must be based on some more or less definite plan of mining and development. For the purpose of presenting costs, the following method has been selected, not with the idea of recommending any particular layout of rooms and pillars, but because it presents a method of mining applicable to the deposits under consideration and furnishes a basis of estimating costs that may be regarded as fairly representative and one that will not vary greatly with changes in the size and arrangement of the galleries, rooms, and pillars. This plan provides for stopes 300 by 1,000 ft. with pillars between adjacent stopes that may or may not be required in actual mining. Casual pillars may be left in the open stopes where required to insure the safety of the backs. The back over the polyhalite beds is solid rock salt containing beds of anhydrite. This salt is firm and solid, and, based on experience in the European mines, may be expected to stand exceptionally well. With very large stopes the behavior of the backs cannot be forecast accurately; experience will determine whether the entire deposit can be mined, leaving the backs to cave, or whether pillars must be left to support the old workings. In any event the backs will be firm enough and strong enough to stand well over the working faces without menacing or hindering current operations. Whatever problems may be presented in determining the size of the open workings and the amount of material to be left as pillars will not materially affect the cost of drilling, loading, and blasting the polyhalite. It is thought that the costs to be presented contain sufficient margin to cover any

Table III—Summary of Mining Costs, Mining of Polyhalite, 2,000 Tons per 24 Hours

Item	Average Number of Men	Cost per Eight-Hour Shift				Unit Cost per Ton Based on 1,000 Tons per Shift				Unit Cost per Ton Mined in Rooms		Unit Cost per Ton from Headings	
		Labor	Power	Supplies	Total	Labor	Power	Supplies	Total	Per Ton Mined, 925 Ton	Mining Cost per Ton of Total Tonnage	Per Ton Mined, 75 Ton	Development Cost per Ton of Total Tonnage
Rooms:													
Drilling and blasting	37	$219.06	$3.94	$127.60	$350.60	$0.219	$0.004	$0.128	$0.351	$0.379	$0.351	.....	.....
Scraper loading	26	124.39	1.39	6.92	132.70	.124	.001	.007	.132	.143	.132	.....	.....
Gathering	6½	33.00	1.85	1.20	36.05	.033	.002	.001	.036	.039	.036	.....	.....
Cost of 925 tons	69½	$376.45	$7.18	$135.72	$519.35	$0.376	$0.007	$0.136	$0.519	$0.561	$0.519	.....	.....
Headings:													
Drilling and blasting	11	$57.54	$1.06	$44.55	$103.15	$0.058	$0.001	$0.044	$0.103	.....	.....	$1.109	$0.103
Loading	4½	22.93	.45	1.29	24.67	.023	.001	.001	.025	.....	.....	.265	.025
Gathering	4	22.00	.26	.80	23.06	.022	.....	.001	.023	.....	.....	.248	.023
Extension of track	5½	26.50	.....	39.00	65.50	.026	.....	.039	.065	.....	.....	.704	.065
Cost of 75 tons	25	$128.97	$1.77	$85.64	$216.38	$0.129	$0 002	$0.085	$0.216	.....	.....	$2.326	$0.216
Cost of 1,000 tons on main sidings	94½	$505.42	$8.95	$221.36	$735.73	$0.505	$0 009	$0.221	$0.735	.....	.....	.....	.....
Main-line haulage	3	16.00	4.00	.60	20.00	.016	.004	.001	.021	.021	.....	.021	.....
Maintenance of tracks	2	10.00	.....	5 00	15 00	010	.....	.005	.015	.015	.....	.015	.....
Maintenance of cars	1½	6.25	.....	6.25	12.50	.006	.....	.006	.012	.012	.....	.012	.....
Dumping at shaft	2	10.00	.....	2.00	12 00	.010	.....	.002	.012	.012	.....	.012	.....
Hoisting	9½	62.85	5.00	8.85	76.70	.063	.005	.009	.077	.077	.....	.077	.....
Haulage and hoisting costs, 1,000 tons at surface	18	$105.10	$9.00	$22.70	$136.80	$0.105	$0.009	$0.023	$0.137	$0.137	$0.127	$0.137	$0.010
Operating costs, 1,000 tons at surface	112½	610.52	17.95	244.06	872.53	.610	.018	.244	.872	.698	.646	2.463	.226
Direct supervision	4	39.00	.....	26.00	65.00	.039	.....	.026	.065	.065	.060	.065	.005
Depreciation	....	.....	.....	.....	76.60	.....	.....	.....	.077	.077	.071	.077	.006
Total direct costs	116½	$649.52	$17.95	$270.06	(a)$1,014.13	$0.649	$0.018	$0.270	(a)$1.014	$0.840	$0.777	$2.605	$0.237
Administration and general expense	13	90.00	.....	60.00	150.00	.990	.....	.060	.150	.150	.139	1.50	.011
Depletion of preliminary mine development	....	.....	.....	.....	47.60	.....	.....	.....	.048	.048	.044	.048	.004
Total mining cost	129½	$739.52	$17.95	$330.06	(b)$1,211.73	$0.739	$0.013	$0.330	(b)$1.212	$1.038	$0.960	$2.803	$0.252

(a) Includes depreciation.
(b) Includes depreciation and depletion of preliminary development.

expense involved in the handling of the backs without this item being specifically included.

Table III summarizes all mining cost items and gives the total cost of delivering the polyhalite at the surface in bins at the main shaft.

Crushing and Grinding—The process for recovering concentrated forms of potash from polyhalite calls for fine grinding in advance of calcination. Experiments on material of various sizes show that treatment of the coarse material does not give as large a yield of potash as the fine material. The yield from material passing a 65-mesh screen is greater than from coarser material and but slightly less than from finer sizes, and below 100 mesh the size of the material makes no apparent difference in the yield. Sixty-five to one hundred mesh is therefore the fineness to which the polyhalite must be ground. The possibility of calcining coarser material (½-in. size) followed by wet grinding is being investigated, but for this estimate it is necessary to assume fine grinding in advance of further treatment. Dry crushing and grinding is indicated.

It is planned to divide the crushing plant into two units, a crushing unit and a fine-grinding unit. The former will operate during two eight-hour shifts per day to match the schedule of mine operations and will deliver a ½-in. product to the second or fine-grinding unit, which will operate 24 hours per day and deliver the final ground product to the treatment plant. This difference in the capacity of the two units is due to the possibility of the direct sale of crude finely ground polyhalite as such or in mixtures of crude and refined salts to supply varying grades of product. The eight hours of reserve time for mine and coarse crushing unit give that much reserve capacity for the production of crude polyhalite to be sold without further treatment, either directly or in a mixed product. Polyhalite for direct sale or for mixed products need only pass an 8- to 10-mesh screen and will be obtained by passing the product from the crushing unit over an 8- or 10-mesh screen, utilizing the undersize, and sending the oversize to the treatment plant.

Sufficient capacity is required to deliver 2,000 tons of polyhalite, crushed to pass a ½-in. screen, in sixteen hours, or 125 tons per hour of operating time. A summary of costs of crushing and grinding is shown in Table IV.

Table IV—Summary of Cost of Crushing and Grinding Polyhalite

Item	Cost of Equipment	Number of Men Per Shift	Number of Men Per Day	Cost per Day, 24 Hours: Labor	Power	Repairs and Maintenance	Total	Cost per Ton of Polyhalite: Labor	Power	Supplies	Total
Crushing	$85,200	3	6	$30	$7.76	$44.00	$81.76	$0.015	$0.004	$0.022	$0.041
Grinding	260,000	2	6	30	52.00	95.70	177.70	.015	.026	.048	.089
Direct crushing and grinding costs	$345,200	..	12	$60	$59.76	$139.70	$259.46	$0.030	$0.030	$0.070	$0.130
Direct supervision	.....	..	3	20	.....	13.30	33.30	.010	.....	.007	.017
Total direct costs	$345,200	..	15	$80	$59.76	$153.00	$292.76	$0.040	$0.030	$0.077	$0.147
Depreciation	.....	..	..	...	.....	.....	115.00	.....	.....	.....	.057
Total costs	$345,200	..	15	$80	$59.76	$153.00	$407.76	$0.040	$0.030	$0.077	$0.204

Treatment of Polyhalite—The treatment process to be described herein has been developed by Dr. H. H. Storch, supervising engineer, and L. Clarke, junior chemist, at the non-metallic minerals experiment station of the Bureau of Mines, at New Brunswick, N. J. This process for the recovery of potassium sulphate and sulphate of potash-magnesia from polyhalite is based on laboratory experiments using samples of polyhalite from Texas and New Mexico. The amount of polyhalite in a 2-in. core is very small, and although additional polyhalite was supplied by the American Potash Company, Carlsbad, N. M., and by the State of New Mexico, the supply proved to be limited and the experimental work has necessarily been performed on a scale much smaller than the importance of the investigations warranted, in order to conserve material. Consequently, some details of the process outlined here require further investigation on a large scale and, at present, estimates only can be made to cover them. Enough careful experimental work has been done to warrant the presentation of the outline of a proposed process for the treatment of polyhalite based on careful research and sound principles and to estimate the probable treatment costs.

Arrangements have been made to obtain an adequate supply of polyhalite, and new equipment has been installed at New Brunswick that will permit further experimentation on large lots of material under conditions similar to those obtaining in a large-scale operating plant. The importance of the deposits and the favorable results obtained from the preliminary experimental work have influenced the Bureau to present this information now rather than to await conclusion of the investigation at New Brunswick.

It should be noted that a general outline of the process with the major operations indicated and discussed in a general way is all that can be presented here. Costs given are somewhat higher than could have been presented in a more detailed study where advantage could be taken of various obvious economies resulting from a definite and completely detailed design.

Original Process—The process developed by Storch and Clarke yields both potassium sulphate and the sulphate of potash-magnesia. Indicated recovery is 86 per cent of the K_2SO_4 in the original polyhalite, of which 31.6 per cent is refined potassium sulphate, and 54.4 per cent of the original K_2SO_4 is in the form of the double sulphate K_2SO_4.$MgSO_4$. The process can be modified to yield refined potassium sulphate only, if that is desirable, with but minor changes in equipment, the yield of potassium sulphate then becoming 78.8 per cent of that present in the original polyhalite.

The polyhalite is to be crushed to pass a 65-mesh screen and calcined for 30 to 60 min. at 824 to 842 deg. F. Then the calcined product will be quenched in hot water and agitated 45 to 50 min. at 210 deg. F. During agitation approximately 2½ parts of water to 1 part of polyhalite is the minimum amount of water for satisfactory recovery of the potash. Ninety per cent of the K_2SO_4 and $MgSO_4$ in the original polyhalite passes into solution, and the $CaSO_4$ remains undissolved and is filtered off together with various other insoluble material, including clay. The quenching in hot water and the agitation at 210 deg. for not more than 50 min. are important factors in the recovery of the K_2SO_4. It is a property of solutions of K_2SO_4 and $MgSO_4$, in equimolar ratio (174 K_2SO_4:120 $MgSO_4$), to yield, on concentration, a certain amount of K_2SO_4 which precipitates and may be separated from the liquor, and further concentration of the liquor precipitates most of the remaining K_2SO_4 as schonite, a hydrated sulphate of potash and magnesia ($K_2SO_4.MgSO_4.6H_2O$) yielding an end liquor that contains all the $MgSO_4$ corresponding to the K_2SO_4 removed, and a small amount of K_2SO_4.

After the gypsum has been filtered off the polyhalite extracts will therefore pass directly to triple-effect evaporators, where they are concentrated to the point where the liquor is saturated with respect to K_2SO_4. This liquor is cooled, and 31.6 per cent of the K_2SO_4 present in the original polyhalite crystallizes out and is filtered off, washed with cold water, dried, and is ready for market. The filtrate is concentrated further in a second evaporator, and most of the remaining K_2SO_4 is recovered as schonite. The schonite is dehydrated in a rotary drier and becomes the double sulphate of commerce.

Modified Process—If K_2SO_4 were the only desired end product, each schonite residue might be redissolved and reconcentrated to yield K_2SO_4 and diminishing remainders of schonite. In the modification of the process to yield K_2SO_4 only, instead of reworking the schonite separately, Storch and Clarke plan to return it to the circuit, where it is dissolved in the polyhalite extracts and re-treated as part of the regular process. A balance can be reached where the schonite in circuit is a constant amount and the amount recovered each day is equal to the amount returned to the process. For this modified process the initial steps of calcina-

Table V—Summary of Production Costs, 2,000 Tons of Polyhalite per Day

Item	Total Number of Men per Day	Cost per Day, 2,000 Tons: Labor	Other Items	Total	Cost per Ton Treated: Labor	Other Items	Total
Original Process, Two Products							
Direct operating costs:							
Mining	226	$1,221.04	$524.02	$1,745.06	$0.610	$0.262	$0.872
Crushing and grinding	12	60.00	199.46	259.46	.030	.100	.130
Treatment	75	430.80	2,713.84	3,144.64	.215	1.357	1.572
Total direct operating costs	313	$1,711.84	$3,437.32	$5,149.16	$0.855	$1.719	$2.574
Direct supervision:							
Mining	8	$78.00	$52.00	$130.00	$0.039	$0.026	$0.065
Crushing and grinding	3	20.00	13.30	33.30	.010	.007	.017
Treatment	10	82.00	55.00	137.00	.041	.028	.069
Total direct supervision	21	$180.00	$120.30	$300.30	$0.090	$0.061	$0.151
Depreciation:							
Mining	...	.....	$248.40	$248.40	.....	$0.124	$0.124
Crushing and grinding	...	.....	115.00	115.00	.....	.057	.057
Treatment	...	.....	705.00	705.00	.....	.352	.352
Total depreciation	...	.....	$1,068.40	$1,068.40	.....	$0.533	$0.533
Total direct costs	334	$1,891.84	$4,626.02	$6,517.86	$0.945	$2,313	$3.258
Administration and general expenses:							
Mining	26	$180.00	$120.00	$300.00	$0.090	$0.060	$0.150
Treatment	22	163.00	109.00	272.00	.081	.055	.136
Total administration and general expenses	48	$343.00	$229.00	$572.00	$0.171	$0.115	$0.286
Total production costs	382	$2,234.84	$4,855.02	$7,089.86	$1.116	$2.428	$3.544
Modified Process, One Product							
Direct operating costs:							
Mining	226	$1,221.04	$524.02	$1,745.06	$0.610	$0.262	$0.872
Crushing and grinding	12	60.00	199.46	259.46	.030	.100	.130
Treatment	72	412.80	2,913.02	3,325.82	.206	1.457	1.663
Total direct operating costs	310	$1,693.84	$3,636.50	$5,330.34	$0.846	$1.819	$2.665
Direct supervision:							
Mining	8	$78.00	$52.00	$130.00	$0.039	$0.026	$0.065
Crushing and grinding	3	20.00	13.30	33.30	.010	.007	.017
Treatment	10	82.00	55.00	137.50	.041	.028	.069
Total direct supervision	21	$180.00	$120.30	$300.30	$0.090	$0.061	$0.151
Depreciation:							
Mining	...	.....	$248.40	$248.40	.....	$0.124	$0.124
Crushing and grinding	...	.....	115.00	115.00	.....	.057	.057
Treatment	...	.....	777.00	777.00	.....	.389	.389
Total depreciation	...	.....	$1,140.40	$1,140.40	.....	$0.570	$0.570
Total direct costs	331	$1,873.84	$4,897.20	$6.771.04	$0.936	$2,450	$3,386
Administration and general expenses:							
Mining	26	$180.00	$120.00	$300.00	$0.090	$0.060	$0.150
Treatment	22	163.00	109.00	272.00	.081	.055	.136
Total administration and general expenses	48	$343.00	$229.00	$572.00	$0.171	$0.115	$0.286
Total production costs	379	$2,216.84	$5,126.20	$7,343.04	$1.107	$2.565	$3.672

tion, extraction, and leaching are identical with the original process, and the amount of water used for extraction is such that when the returned schonite is dissolved in the hot polyhalite extracts, the resulting solution will be saturated with respect to potassium sulphate, which on cooling precipitates and is recovered. This method eliminates the first set of evaporators, and the process continues as before for the recovery of the schonite, which is returned to the circuit.

The relative amounts of material to be handled in the two processes are such that although the first set of evaporators is eliminated in the modified process the total evaporator capacity employed in the original process is almost exactly what will be required for the recovery of the schonite in the modified process. Thus, by introducing agitators in which the schonite added to the circuit may be dissolved, and by slightly increasing the capacity of the equipment for the original process, a plant is devised that can deliver either potassium sulphate alone or a combination of potassium sulphate and dehydrated schonite, the sulphate of potash-magnesia.

Basis of Cost Estimates—The estimates of equipment and operating costs that follow are based on the treatment of 2,000 tons of polyhalite in 24 hours. Continuous operation with three eight-hour shifts per day has been assumed, and the unit cost of plant labor has been taken at $6 per shift. Power and steam costs are taken from the estimated cost of power and boiler-plant operation. Direct costs only are shown here. Such indirect items as depreciation and overhead expense are added to the summarized direct costs rather than to each item of operating cost.

The polyhalite on which this treatment process is based has the following composition: K_2SO_4, 25 per cent; $MgSO_4$, 17.2 per cent; $CaSO_4$, 50.6 per cent; H_2O, 6.2 per cent; NaCl, 0.5 per cent; insol (SiO_2, Fe_2O_3, etc.), 0.5 per cent.

Pure polyhalite ($K_2SO_4.MgSO_4.2CaSO_4.2H_2O$) has the following composition: K_2SO_4, 28.9 per cent; $MgSO_4$, 20 per cent; $CaSO_4$, 45.1 per cent; H_2O, 6 per cent.

Table VI—Total Costs

	Total per Day	Per Ton of Polyhalite
1. Original process:		
Mining	$2,423.46	$1.212
Crushing and grinding	407.76	.204
Treatment	4,258.64	2.129
Total cost	$7,089.86	$3.545
2. Modified process:		
Mining	$2,423.46	$1.212
Crushing and grinding	407.76	.204
Treatment	4,511.82	2.256
Total cost	$7,343.04	$3.672

The material to be treated is evidently polyhalite with a small admixture of anhydrite ($CaSO_4$).

Summary of Costs

The equipment costs are as follows:

Mine (equipment and preliminary development)	$1,387,780
Crushing and grinding plant	345,200
Treatment plant	1,589,300
Power plant	888,000
Total equipment and development costs for capital account	$4,210,780

The total does not include the purchase cost of the mining property, the cost of preliminary research on the treatment process, or current working capital. In general, the capital required to develop and equip a property to handle 2,000 tons of polyhalite in 24 hours will range from $4,000,000 to $4,500,000.

Table V shows the total cost of mining, crushing, and treating 2,000 tons of polyhalite per day.

The total cost of production and the cost per ton of polyhalite mined and treated are given in Table VI.

The total cost of the above production at the treatment plant was $7,343.04, and the cost of the product is:

Per ton of salt (90 per cent K_2SO_4)	$16.84
Per ton of K_2O content	34.47

Final Costs

In general, using even figures, the average cost of 90 per cent potassium sulphate may be assumed at $16 per ton at the plant, and the double sulphate of potash-magnesia at $8 per ton at the plant.

Products Obtained

Original Process—From the process two products will be obtained, as follows: Potassium sulphate (K_2SO_4), 148 tons per day, with which are mixed 19 tons of syngenite ($K_2SO_4.CaSO_4.H_2O$); and double sulphate of potash-magnesia ($K_2SO_4.MgSO_4$), 459 tons per day of the dried product.

These recoveries are based on pure salts, but as actually recovered the salts will be only about 90 per cent pure. When expressed in terms of the ordinary commercial grades, 90 per cent pure for potassium sulphate and 48 per cent K_2SO_4 for the double salt, the tonnage of products obtained and the content of K_2SO_4 and equivalent K_2O will be as shown in Table VII.

The total cost of the salts mentioned in the foregoing at the treatment plant was $7,089.86. If this total cost is

proportioned to the K_2O in each product the costs of the two different products are as follows: Total cost, $7,089.86; total K_2O produced, 232.5 tons; cost per ton K_2O, $30.49. Potassium sulphate (90 per cent K_2SO_4): Cost of 85.5 tons K_2O as sulphate product, $2,607.24. For 176 tons of salt this is $14.81 per ton. Double sulphate (48 per cent K_2SO_4): Cost of 147 tons of K_2O in double salt, $4,482.61. For 567 tons of salt this is $7.90 per ton.

Table VII—Products Recovered

	Salts Recovered, Tons	K_2SO_4 Content, Tons	Equivalent K_2O, Tons
Potassium sulphate:			
K_2SO_4	157	148.0	80.0
Syngenite	19	10.1	5.5
Potassium sulphate recovered	176	158.1	85.5
Sulphate of potash-magnesia	567	272.0	147.0
Recovered from original process	743	430.1	232.5

Modified Process—From this process only one product, potassium sulphate, will be obtained. Three hundred and eighty-four tons per day of K_2SO_4, with which are mixed nineteen tons of syngenite, will be recovered. As before, this tonnage is based on pure salts and when expressed in tons of commercial salt containing 90 per cent K_2SO_4 the product will be as indicated in Table VIII.

Polyhalite beds of sufficient size and thickness to be economically mined and treated are known to occur in western Texas and southeastern New Mexico.

A process for the treatment of polyhalite to recover refined sulphate of potash and sulphate of potash-magnesia has been evolved, and these products, together with lower-grade mixtures of crude and refined salts, can be produced at a cost that enables them to be sold at a profit in the principal markets of the United States in competition with foreign potash salts.

A profitable market for salts of domestic origin seems assured both on the basis of present price levels and in the face of a reduction in the price of foreign salts to the level of their actual cost of production and delivery in the United States.

Potash prices are likely to remain fairly stable at present levels as long as the Franco-German agreement remains in effect and until the German industry has completed its reorganization and relieved itself of its present burden of debt and unproductive and idle assets. When this has been accomplished, a reduction in the price of potash salts appears probable, but such a reduction will not be a drastic one.

Reductions in the price of foreign potash salts aimed directly at a growing American industry seem very unlikely on account of the importance of the domestic market in Germany and France, and the fact that a cut in prices which would be effective against an American industry would mean a corresponding cut in domestic prices and loss of profits in these important domestic markets.

Potash production in Texas and New Mexico must face an increasing competition from Searles Lake, in California, which now produces about 15 per cent of the American consumption of potash and is growing rapidly, but Searles Lake is subject to the same freight disadvantage as the Texas-New Mexico area with respect to domestic markets. The Searles Lake production is confined to muriate, and for those special purposes where sulphate salts are required or desired there would appear to be no competition between polyhalite products and Searles Lake muriates.

With an assured and a growing market in the United States accessible to polyhalite products and with production costs at a level that assures profits in the face of any probable or even possible price competition, and with the special advantages of the sulphate salts of potash and magnesia in fertilizers, there should be no doubt of the economic importance of these polyhalite deposits as the basis of a profitable American production of potash salts.

Table VIII—Products Obtained by Modified Process

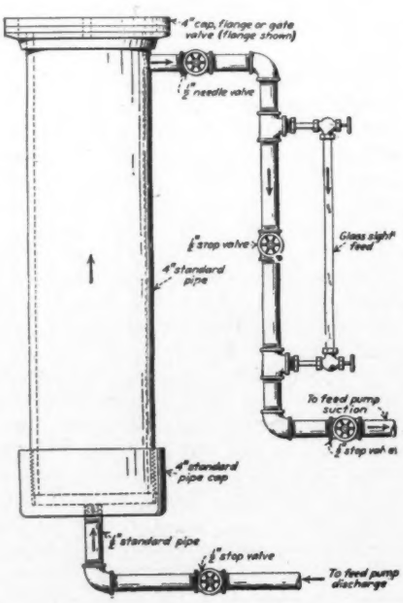
	Salt Recovered, Tons	K_2SO_4 Content, Tons	Equivalent K_2O, Tons
K_2SO_4	417	384	207.5
Syngenite	19	10.1	5.5
K_2SO_4 recovered from modified process	436	394.1	213.0

The opportunity for development of a prosperous American industry is presented; and the slate is still clean. Unrestricted exploitation, in the face of a distinctly limited market, will result in such overproduction as can only bring disaster. A wise policy of development will build an industry in which every American can take pride and from which the American farmer can be assured of potash from a domestic source at reasonable cost.

System for Feeding Boiler Compound

THE PROPER feeding of boiler compound is an important subject that has not received the attention it deserves, writes J. H. Gullak, in *Power*. Chemicals or compounds used for such a purpose should be fed to the boiler evenly and continuously in direct ratio to evaporation. Under no conditions should the balance between these two factors be radically disturbed.

A method used to advantage is shown in the accompanying illustration. This procedure does not give minute accuracy, but it is cheap and, except where high pressures and overloads are considered, it feeds the chemicals to the boilers accurately enough for general purposes. In a battery of boilers the densities will sometimes build up in an uneven and unbalanced manner. One boiler will absorb more chemicals than another, and the evaporation of individual boilers will differ. But, for practical purposes, if the quantity of chemicals used is based on the boiler requiring most, the slight excess that will enter the boiler requiring least will cause no harm or complications.



Compound feeding device for chemicals in solid form

The device shown in the illustration is particularly adaptable for chemicals in solid form. For liquids and powdered chemicals, an ordinary drip tank, with a gage glass and drip cock, will serve. The dissolved material can be fed to the hot well, to the heater, or to any other place in the system that lends itself to the purpose. In an entirely closed system, where a high degree of accuracy is required, a more elaborate method can be used. In that case, the chemicals should be pumped into the boilers continually and evenly in accordance with the evaporation evident from the flow meter or otherwise determined, and not intermittently. Where an automatic make-up feed regulator is used, the drip valve from the chemical tank should be actuated by the regulator and float in the constant-level feed tank applied under such conditions.

Selection Trust Develops a Lead-Zinc Property in Yugoslavia

George L. Walker

UNDER a surface excavation in which weeds and shrubs have been growing undisturbed for five centuries a highly important lead-zinc mine—with about two million tons of ore having a gross value of £4 11s., or over $22, per ton—has been developed in Yugoslavia during the last three years. The development is made particularly interesting by the fact that most of the other ore deposits in Europe which had been worked and abandoned in early times by various peoples, including the Romans, have proved on re-examination to be small and unimportant.

In 1925, Selection Trust, Ltd. (A. Chester Beatty and associates) became interested in two mineral exploration concessions known as the Trepca Right and the Rogozna Right, in Serbia, Yugoslavia. The stories of extensive production of precious and non-ferrous metals there in the time of the Romans, and later, seemed exaggerated, but careful and extended historical research disclosed numerous scraps of information which appeared to confirm these reports.

From about the twelfth century until the fifteenth, when Serbia came under Turkish rule, the area was, the records show, an active mining province. In those times the mines were reputed to be very rich. Nothing was found in the historical records to indicate that the mines had been exhausted, and much evidence was adduced which indicated that Turkish administrative methods were solely responsible for the cessation of operations.

Immediately after the conquest of the region by the Turks, the Turkish government apparently prohibited the export of metals, but endeavored to force the conquered people to keep up production. "The exploitation of the mines," wrote Caterino Zeno, the Venetian Ambassador, in 1550, "is one of the tyrannies imposed by Turkey."

If historical records are reliable, the methods employed were indeed unique. A rich primate, usually a Greek, would, independently of his consent, be appointed as contractor of a mine. If he operated at a profit he derived a certain benefit; if not, he answered with all his property to the Turkish government. As they were likely to be enslaved, as many actually were, the skilled workers emigrated, and the mining art was finally forgotten in Serbia.

With such sketchy bits of history for encouragement, but without a scrap of knowledge concerning the geology, Selection Trust sent engineers, first John A. Dunn and later Harold A. Titcomb, to Serbia. At what is now known as the Stantrg mine these engineers found a hole in the ground. But it clearly was what remained of a large excavation, being 262 ft. (80 m.) wide and 557 ft. (170 m.) long; and the discovery that the mounds near by were piles of waste ore made the property decidedly interesting. From this excavation, along lines extending back for several thousand feet, other pits and old shafts were found. Evidence indicated that large quantities of ore had been removed from these. They definitely confirmed the stories of extensive mining activities over a long period in earlier centuries.

Interesting at first sight, these old workings became more so later. In them have been found various relics, including old mining tools, coins, coin dies, a gold ring bearing the Lion of St. Mark in mosaic, as well as occasional heaps of bones of the old miners themselves.

At the time of the second examination assessment work had to be started, so it was decided to extend an adit from the hillside and get under the big Stantrg pit. This adit soon ran into sulphide ore. Galena and sphalerite, with associated pyrite, occurred as a replacement deposit in limestone. In this way the usual plan was reversed, the study of the geology following rather than preceding ore development. A thick series of limestones overlain by schists had been folded into an anticline, and along the axis of this an intrusion of andesite had thrust itself

Mill and power plant site at the Stantrg mine along the Ibar River and the new railway line from Kos Mitrovica

Portal of deep level adit which cuts the Stantrg orebody 600 ft. below the developed section of the mine

through both formations. Along the side of this intrusive a band of volcanic breccia was encountered. The limestone adjacent thereto evidently had been extensively replaced by ore.

The idea suggested itself that the breccia would follow the intrusive, and the ore the breccia, both laterally and to depth. So development work was planned accordingly and pushed forward. By this plan of operation an ore tonnage was developed so rapidly that the two exploration rights, covering an area of about 409 square miles, were purchased in 1927. Trepca Mines, Ltd., was organized to take over the properties and operate them. Development work has been continued with great energy. The property is under the management of A. S. Howie, who was formerly with Backus & Johnson, at the Morococha property, in Peru.

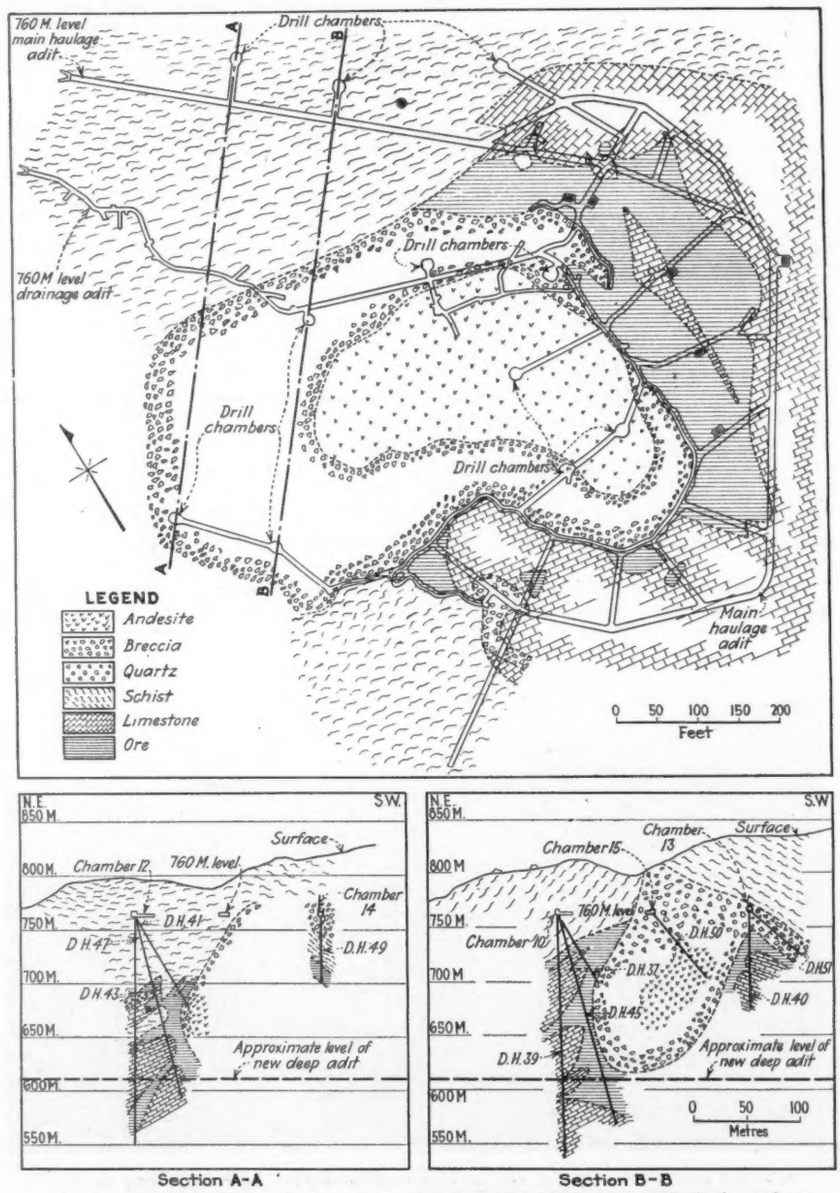
Up to July, 1929, when Trepca Mines made its first and only public offering of stock, 1,750,000 tons of ore had been proved, averaging 11½ per cent lead, 10½ per cent zinc, and 3 oz. silver per ton. Four main adits had been driven into the ore at vertical intervals of 30 m. Each of these was driven along the breccia contact, and crosscuts were sent out from at intervals through the orebody. Widths up to 50 m. (162 ft.) had been disclosed, and on the lowest level the length of the deposit is about 350 m. (1,148 ft.)

More recently diamond drills have cut the downward extension of the big orebody about 400 ft. below the bottom of the measured tonnage. At that depth the ore seems to maintain its excellent grade in lead as well as in zinc.

The diamond drilling has been done from five drill chambers cut on the third, or 830-m., level, and from nine other chambers cut on the new fifth, or 760-m., level. Though only "Bravo" (Sullivan) hand-operated drills have been used, up to Sept. 20, 1929, 44 holes of an average length of 240 ft., a total of 10,560 ft., had been drilled. One hole was put down 744 ft. and another 644 ft. The average cost of this drilling has been only 13s. ($3.17) per foot.

Trepca Mines, Ltd., sold 1,600,000 shares publicly at a price of 5s., thus providing itself, after underwriting and issue expenses, with £380,000 ($1,846,800) in cash. This is expected to equip the property for production and permit the investigation of other old workings in the near vicinity.

A. G. McGregor has the plans for the Trepca concentrator in hand. It will be of 500 tons' daily capacity. Together with power plant, railway sidings, ropeway, ore bins, and office, the estimated cost is £225,000 ($1,096,000). Underground equipment, air compressors, workshops, and other costs of preparing the Stantrg mine for production are expected to absorb £42,500 ($207,000), and for the further underground development of the mine



General geological plan of 760-m. level of Stantrg mine, and geological sections

and the exploration of the remainder of the property £50,000 ($243,500) has been allocated. In this last item is included the expense of driving a new deep adit, which will be 7,500 ft. long and will cut the ore 150 m. (nearly 500 ft.) below the lowest existing adit. This deep adit has been under consideration for several months. Now that the diamond drills have proved that the ore extends to that depth and below, the work of driving it is starting. An official estimate of recoveries, costs, and profits, under the market conditions prevailing during September-October, 1929, resulted as follows:

"Taking the prices of lead and zinc at £22 and £25 per ton (4.78c. and 5.40c. per pound) respectively, silver at 24d. per ounce, assuming an 85 per cent recovery, and allowing for dilution in mining and the extraction of lower-grade ore not included in reserves, a revenue of about 47s. ($11.47) per ton of ore milled should be realized. This would show a profit of about 22s. ($5.37) per ton, which, on a basis of treating 150,000 tons per annum, is equivalent to a profit of £165,000 ($803,550) per year."

In the matter of costs the company seems to have much in its favor. The Stantrg mine is five miles from Kos Mitrovica, which till recently has been the terminus of the railway coming down from the north. This railway is now being extended down the Ibar River. It will shorten distances on shipment of concentrate to smelters in England and Belgium by providing a direct route of only 200 miles to Cattaro Bay, on the Adriatic. The railway extension is to be completed within another year.

Constructing crusher and ore-bin foundations at the Stantrg mine

Mining costs are expected to be low, as the orebody is a relatively vertical one of great width, and there will be neither pumping nor hoisting expenses for many years. Labor is plentiful and efficient, and the company has the fullest co-operation of the Yugoslavian government.

There is already a good prospect that the Trepca Mines will soon have sufficient ore proved in the Stantrg mine, and in other deposits near by which are now being explored with encouraging results, to warrant erection of both lead and zinc smelters in Yugoslavia.

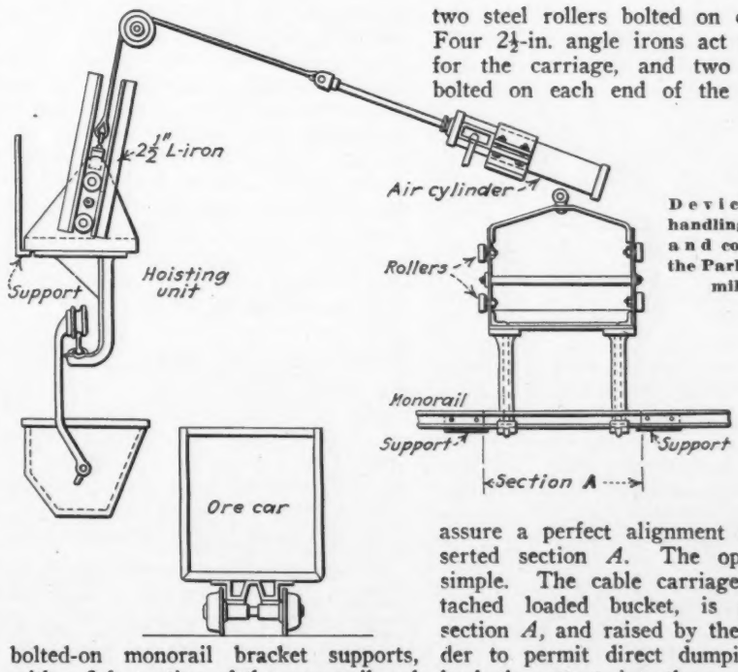
Though until quite recently attention has been centered largely on the Stantrg mine, the results of the development there alone seem to have opened up great possibilities for the orebodies indicated by the several other abandoned workings grouped near by. The existence of old stopes of considerable size in some of these workings has already been ascertained.

An important mine is being developed, and the region in which it is situated is probably destined to prove an important lead-zinc mining district.

Monorail Hoisting Equipment Cuts Labor Costs

AT THE Park City unit of the Park Utah Consolidated Mining Company, the ore, concentrate, coal, and coke are transported by a rope tramway from mill terminal to railway depot and vice versa, writes J. B. Huttl from Salt Lake City, Utah. To convey incoming material to the upper mill floor and tunnel level, the tramway, through a switch, is directly connected to a light monorail system, which enables the operator to place the cable carriage as closely as possible to the mill elevator. Difficulties, however, were experienced in transferring coal or coke to the aforementioned points, as the monorail is installed at an elevation too low to permit direct dumping of the bucket contents into ore cars. The coal or coke first had to be emptied on the mill floor, then shoveled by hand into the cars.

To avoid this labor, a cylinder, operated by compressed air, a pulley, and a hoisting carriage were constructed and installed, as shown in the accompanying sketch. The hoisting carriage, made of angle iron and $\frac{3}{8}$-in. sheet iron, has two bolted-on monorail bracket supports, with a 3-ft. section of the monorail and two steel rollers bolted on each side. Four $2\frac{1}{2}$-in. angle irons act as guides for the carriage, and two supports, bolted on each end of the monorail, assure a perfect alignment of the inserted section *A*. The operation is simple. The cable carriage, with attached loaded bucket, is placed on section *A*, and raised by the air cylinder to permit direct dumping of the bucket's contents into the ore car.



Device for handling coal and coke at the Park City mill

The Problem of Essential Minerals

A. H. Hubbell
Associate Editor

WAR between the great nations seems most remote. Recollections of the hardships caused by the latest struggle are still vivid. Present financial burdens are a potent reminder. Part of these burdens is chargeable to present armaments. Conferences now in progress having for their purpose the limitation of armaments indicate the desire of the powers to ease this strain upon their exchequers. More than this, they signify a growing realization that, although war may at times force itself upon a nation, it is out of date, disreputable, and a costly way for civilized, cultured peoples to settle disagreements; that, if the nations must be armed, their armaments should be for defensive purposes only.

Armament for defense is generally admitted to be legitimate. The nations have been too short a time upon the path of peace to leave themselves unprotected. Though war appears remote, preparedness for a possible war seems wise. And, since war cannot long continue without the support of a nation's industries, those industries must be considered in any program of preparedness.

BASIC as they are in the economic structure, the industries supplying raw materials must receive first consideration. Prominent among them are the mining industries. Iron and steel have long been recognized as sinews of war. But when this country entered the World War in 1917, certain minerals, formerly inconspicuous, took on a new importance. These were pyrites, chromite, manganese, and potash. Essential they were called—essential to the prosecution of the war. They were not the only essential minerals, but their essentiality was emphasized by the fact that developed domestic resources of them did not exist in the United States. Mined to only a limited extent or not at all in this country, they had been imported from abroad to meet industrial needs. But a growing scarcity of ships forced curtailment of these imports, and those responsible for producing munitions and supplies sought nervously to meet at home the country's requirements.

The war over, officials, alive to the wisdom of insuring a supply of such essential minerals, continued to give the problem study. Though not easy, the problem is simply stated: To insure to the nation in case of war a supply of each essential mineral sufficient for the successful conduct of the war. It presents itself as a problem to the departments of the government concerned with national defense; to organizations, such as the national engineering societies, that naturally might be expected to study it and make recommendations to the government; to the technical press; and to any individual, group, or industry sufficiently interested to consider it. On the first named only is it incumbent to find a solution. Companies and individuals owning deposits of these minerals or desirous of engaging in their development, however, become immediately concerned with all the aspects of the problem.

Where an essential mineral does not occur at all in the United States,[1] the problem of insuring a supply of it for war-time use is reduced to that of providing a stock imported from abroad, not to be drawn upon until the emergency arises. The size required for such a stockpile will depend on the requirements of the essential industries consuming the mineral, and on the probable length of the period during which imports will be cut off. Both of these factors require to be estimated. Obviously, beyond the provision of a stockpile, no remedy exists for a possible shortage of this particular mineral save the devising of a substitute.

IF DEPOSITS of this essential mineral exist, however, and if some are wholly or in part of such grade, physical characteristics, and tonnage and so situated with respect to transportation that the owner can work them profitably without other assistance than the provision of capital in the customary manner, the commercial portions will be worked unless the owner cannot secure the capital, or is lacking in enterprise, or the fee is legally entangled. In any case, the assumption that they are commercial means that the technical or economic problems they offer can be solved. They may of course be insufficient in tonnage to provide a dependable resource. Being workable at any time, moreover, they may conceivably be worked out by the time that any possible emergency arises.

With respect to the uncommercial balance of such a mineral resource, or a resource consisting entirely of ores of poorer or more refractory quality that are not susceptible of being mined, treated, and marketed at a profit, the case is different. One fact stands out regarding them: No company or individual—indeed, none except the government—can afford to work them so long as no chance exists to make a profit. They will remain unworked, save for the aforesaid possible action by the government, which will be free to act only on government-owned land or by virtue of special new legislation elsewhere.

A TARIFF or subsidy is necessary, therefore, if these otherwise unprofitable ores are to be worked at a profit by private individuals or companies. The mere granting of protection, however, does not of itself imply that protection will be continued. A tariff imposed may also be removed. This fact may cause capitalists to hesitate before putting money into the development of a new industry that can exist only with artificial protection. Where the industry is not new, but is dormant from lack of protection, and already represents a considerable investment, capital will be more likely to enter it on assurance of protection, in the hope of securing and recovering the investment already made.

Views differ as to the desirability of tariff protection for raw materials. Those opposing such protection argue

[1] Of the four essential minerals mentioned, all occur in the United States, even potash having recently been found in what are thought to be commercially workable deposits in New Mexico and Texas. But in the future, other minerals not now of economic importance may come to be regarded as "essential, but lacking."

that it penalizes the domestic manufacturer using the raw material, in that he must pay more for this material than does his competitor abroad, the latter thus having an advantage over him in the market. A disadvantage this undoubtedly is, but one that may be overcome, so far as the domestic market is concerned, by protecting the manufactured product correspondingly. In the export field the disadvantage would be without a remedy and must be weighed against the advantages of protection to determine the net value of the latter.

OPPONENTS of protection for raw materials also argue that, the United States being predominantly an industrial nation, the policy best for the majority is to secure to its industries the widest possible market for their products at the best price obtainable, and to insure to them an ample supply of cheap raw materials. Such a policy undoubtedly makes for maximum prosperity for the greatest number. It does not necessarily mean maximum prosperity for the nation, however, if under it the two great divisions of mining and agriculture suffer. The miner out of work is as sad an object as the factory hand in similar plight, even though there are many more of the latter. Opposition to protection for raw materials in general on such grounds is not justifiable. Some of the mining industries might be deserving of protection; others not. Each raw material, mineral or otherwise, should logically be examined apart from all the others to determine its worthiness for protection.

Argument is also made that raw materials should come in duty free to insure maximum economy in using them, because there is only one crop of them, unreplenishable when consumed, and modern civilization is dependent, and so far as can be seen, will remain dependent, on their use.

Civilization indeed appears to be dependent on an unrenewable crop of minerals. But when a nation creates a tariff to stimulate the development of its resources of any mineral, it does not hasten consumption of the world resources of that mineral by a single pound. Total world consumption of that mineral is independent of national tariffs, save as a tariff causes consumers of the country creating it to seek a substitute. Consumption of the portion of the world resources that lies within the borders of the nation establishing the tariff is indeed hastened (save as a substitute is developed), consumers using domestic ore in place of imported, so that consumption of the latter decreases correspondingly.

BUT if the protected national resource be so large in proportion to the demand that it will probably last for a generation or more at the normal rate of consumption, the fact that the tariff protecting it tends to cause its exhaustion sooner than otherwise is a matter of small moment. Solicitude for the welfare of distant generations can easily become ridiculous, in view of our ignorance of the future.

International control of mineral resources, apparently accompanied by and based on a policy of free trade in those resources, is advocated by some as providing a means of avoiding the wasteful use of world resources and at the same time insuring to each nation its requirements of essential minerals, this because the nations are not equally endowed in respect to such resources. Whatever be the details, the scheme these advocates have in mind would involve essentially an understanding between the two English-speaking world powers, which hold 75 per cent of the mineral resources of the globe within the boundaries of their dominions, and an agreement between their respective mineral producers—that is to say, a cartel. Such a scheme of international control, if it proved practicable, could undoubtedly be utilized to divert mineral supplies from any use deemed wasteful, and to this extent to prevent unnecessary depletion of world resources. But removal of tariff barriers, as proposed by these advocates, although it would facilitate international trade in minerals, would serve in no way to help to provide a supply of essential but lacking minerals in an emergency. (Nor would it prevent a diminution in the world's stock of minerals any more than the erection of tariff barriers would cause such diminution, for reasons previously set forth.) Neither would international control, to consider the main proposition apart from questions of tariff, of itself insure that this nation would have in an emergency a supply of desired essential minerals of which it had scant natural resources. The problem of providing such a supply in the interest of preparedness would still exist just as if there were no scheme of international control. Emergencies with respect to supply of essential raw materials do not arise because of tariffs or because of lack of international agreements and controlling bodies, but because of lack of ships and/or because supplies once available have become locked up in enemy countries.

EVIDENTLY, then, a sound argument against tariff protection for all mineral raw materials, without discrimination, cannot be made. Protection may therefore be regarded as a legitimate, proper, and economic means for stimulating the development of an infant, mineral, raw-material industry where study of all the facts involved indicates that the advantage thus to be gained will outweigh any possible disadvantages. Of paramount advantage to the United States would be the insurance or actual provision of a supply, where lacking, of every essential mineral, sufficient to safeguard the country against the consequences of such lack in an emergency.

One may proceed, therefore, to examine as to its feasibility the proposition to develop with the aid of a tariff a resource of an essential mineral not workable without a tariff, the purpose of such development being to insure a supply in case of an emergency curtailing imports. Two cases may be considered, where (1) the tonnage is limited as compared with normal current demands; and (2) where the tonnage is large.

IN THE first case, tariff protection would undoubtedly have the result of exhausting at an early date the limited resource, after all problems attendant upon production of the mineral in marketable form had been solved. Inasmuch as war appears remote, and all present tendencies are toward greater amicability among the powers, such point of exhaustion would probably be reached before an emergency arrived. Annual consumption of each of the so-called essential war minerals in the United States is large. Conservation of this typical limited mineral resource, rather than its exploitation, is therefore necessary, if it is to safeguard the country against an emergency shortage.

At the same time, if this resource is to act as an emergency safeguard, its ore must be quickly available when the emergency arises. Of this no assurance can be had, if it be conserved, unless the time-consuming mine development, process development, and plant erection have been begun and have reached the production point before the emergency's arrival, something clearly impracticable to propose, inasmuch as there is no profit in it for the company or individual undertaking the development. Here again, only the government could do it.[2]

A DILEMMA therefore presents itself; if this low-grade resource of limited tonnage be exploited with the aid of tariff protection, it will probably be exhausted before it can fulfill its proposed function as a safeguard. If, on the other hand, it be conserved, it will not begin to yield its ore until some indefinable period of time after the arrival of an emergency. To overcome this difficulty, the expedient of a stockpile must again be adopted to guard against a lack of ore between the arrival of the emergency and the date when the emergency reserve is brought into production. Here the size of the needed stockpile will depend on the

[2]Some argue that even though a previously unworked resource could not be brought into production immediately upon development of a war emergency, this would present no real difficulty, inasmuch as the government and industries requiring a supply of the particular mineral involved would not be in a position immediately to use it, even if available, because plants would first have to be converted from peace-time to war-time purposes, and in the resultant delay domestic mineral producers would find ample time to develop their supply. The correctness of this view is extremely doubtful, especially when one considers that the very essence of a program of preparedness for a defensive war is to obviate all such delays.

probable length of time required to get the reserve into production.

Consideration of the first case—namely, where the tonnage is limited—leads to the conclusion, therefore, that the development of such a resource should not be encouraged, but that the resource should be conserved, and should be supplemented with a stockpile of a size depending on the character of the resource.

In the second case, the resource differs from the one just considered only in being large in the aggregate instead of small. In quality, so far as can be seen at the outset, it is just as poor as the first one and just as unmarketable at prevailing prices without beneficiation. Though the total resource is larger than before, individual deposits may not be, so that cheaper mining is not reasonably to be counted upon.

The resource of this essential mineral being large, however, its exploitation can be undertaken at any time without fear of quickly exhausting it. It may be large enough to supply even peacetime needs, when beneficiated, as far ahead as can be seen. Development of any large resource, low-grade or otherwise, comprising many occurrences of ore in widely scattered localities, is most likely to disclose important additions to the reserve, if the ordinary experience of the mining industry be a fair criterion. Stimulation of such development by a protective tariff, if continued, should result in the establishment of a new domestic industry, advantageous in peace and fulfilling in wartime the purpose for which it was established.[3]

If tariff protection be denied this large resource, with the purpose of conserving it untouched until an emergency cutting off imports arises, a stockpile to supplement it would be necessary as before, and for similar reasons.

RECAPITULATING the arguments for Cases 1 and 2, and bearing in mind that tariff protection is a proper means of stimulating the development of an infant, mineral, raw-material industry, one finds that a limited low-grade resource of an essential mineral should be conserved by the simple means of denying it a protective tariff, and that at the same time it should be supplemented with a stockpile; but that if the low-grade resource is large, it may be developed as in the case of any other domestic industry, but with the added purpose of insuring a supply in an emergency, without dependence on a stockpile, provided that adequate tariff protection be granted.[4]

If a proposal be made, therefore, to foster with an adequate tariff the development of a mineral industry said to be essential, it is necessary only to determine (1) to what extent the mineral may be classified as a war essential, and (2) if the domestic resource of it is large in proportion to the current and prospective demand.

Tariff protection for manganese has been advocated by some because of its peculiar essentiality to the steel industry, which of all the country's industries is the most basic and most important. Because of this essentiality, the development of a domestic supply of manganese has appeared highly desirable and something to be striven for in the interest of preparedness, if it could possibly be achieved. There being no question of the essentiality of this mineral, it appeared necessary to inquire only if the domestic low-grade resource was large enough to suffice to supply the needs of industry, when beneficiated, for as many years ahead as it was reasonable to inquire. Here again the answer appeared to be in the affirmative, and, since the inquiry first was made the known resources of low-grade ores and manganiferous materials have been augmented by new discovery. With the aid of a tariff and the research that is possible only by virtue of a tariff, it has seemed reasonable to assume that the development of a domestic industry was feasible.

(To be concluded)

[3] Some will say that, to justify a tariff, it should be possible to show that an industry can be built up which within a reasonable number of years will be able to take care of itself without a tariff. This, however, is not a principle that has been followed in practice in the United States, where industries other than those of infant proportions enjoy protection.

[4] Development may be slow at the outset, if the domestic market is narrowly restricted, as where primary consumers are few in number and possibly have investments in foreign ore-producing enterprises.

Safety First at the Matahambre Mine

TWO years ago Minas de Matahambre started a systematic, aggressive safety-first campaign at its property in Cuba. H. C. Henrie, of the Phelps Dodge Corporation and the National Safety Council, was invited to make a study and report on local conditions. This report was used as a guide in starting an intensive safety-first campaign. Safety-first committees were organized in all departments. These committees, consisting of employees in the departments, meet regularly. In addition, a general safety committee was formed, composed of superintendents of the various departments, the general manager being chairman of this committee. A safety-first flag is raised over the department having the best record each month. Every department has now had this flag at some time.

Elimination of lost-time accidents in the mine has been especially difficult, owing to inexperienced labor and the prejudice of mine workmen against any interference with their old ideas. Most lost-time accidents in the mine were the result of injuries to the head or feet. All men must now wear "hard-boiled" hats. Prior to the safety-first improvements, practically all workmen underground wore rope-soled canvas shoes. These shoes are no longer permitted in the mine or in any other department. Every workman must wear leather shoes. A steady decrease in lost-time accidents since this rule was put into effect has resulted.

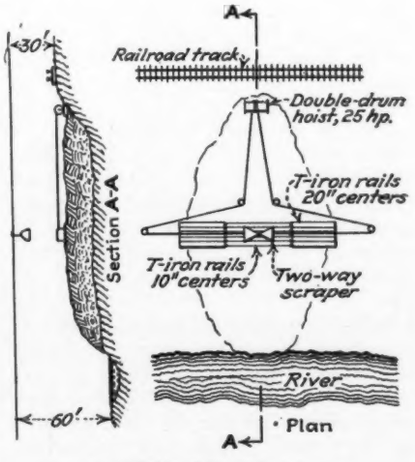
Some time ago notices were posted that when the mine passed a period of 30 days with no lost-time accident, a general holiday would be declared and a "fiesta" given the entire town. On Aug. 16, 1929, the mining department terminated a period of 46 consecutive days with no lost-time accident. The 30-day period with no lost-time accident was accomplished on Aug. 1, and on Aug. 11 the "fiesta" was given as promised. Three thousand people were fed at a general barbecue.

The man-shifts worked in the mine during the 46 days with no lost-time accident were 31,371.

■

Scraper to Spread Rock From Rope Tramway

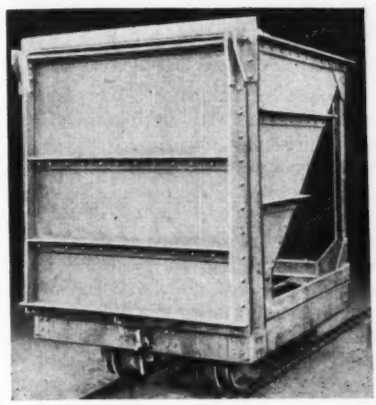
A SIMPLE, one-man method of spreading rock dumped from a rope tramway is described in *Coal Age*. It is shown schematically in the accompanying sketch. Directly under the rope is laid a floor of T-iron rails of 60-lb. weight, set at about 10-in. centers, on which rock is dumped from the buckets. This floor is extended across the dump by 25-lb. T-iron rails set at 20-in. centers, and on it moves a two-way scraper operated by sheaves and ropes to a 25-hp. double-drum hoist. The idea has the merit of simplicity, and requires only portable equipment.



Spreading Rock on Dump

Shaft Sinking in Tennessee

Lamar Weaver



Four-ton transfer car for waste disposal on surface.

THE Burra Burra mine of the Tennessee Copper Company, at Ducktown, Tenn., has two three-compartment shafts—Burra and McPherson. These are about 2,200 ft. apart along the strike and are connected by haulage drifts at 200-ft. vertical intervals. The Burra shaft is sunk on a 74-deg. incline down the footwall and handles most of the mine production. The McPherson shaft is vertical and passes from hanging wall to footwall. Progress in sinking the two has averaged 160 ft. per year, the work having been pursued periodically in campaigns of 250 to 450 ft. Crews were picked from the best miners of the organization and a bonus was paid for speed. The results were: too large a force of men, unpleasant working conditions, greater hazards, and a periodic upset in the organization, all of which were dearly paid for in cost per foot. Finally, a new plan for doing this work was devised. As described in the following, it involved the careful working out of the details of operation for a small crew with specific routine duties, with the objectives of economy in sinking, minimum interruption of mine operation, and commensurate speed.

The work of sinking McPherson shaft under the new plan from the 16th to the 18th level, under the protection of a 12-ft. rock pentice in the hoist compartments, has just been completed. It was done in the footwall rock, this consisting chiefly of graywacke, schist, quartz, and pseudodiorite, and involved what the company classed as medium to hard drilling and blasting. Two of the shaft's three compartments, it should be explained, are used for balanced hoisting and the third is used for ladder and pipes. McPherson is the supply shaft for the Burra Burra mine, supplies being handled on day shift by four surface men. These men unload and rack supplies from railroad cars, deliver the material to the cage on order, handle drill steel, sharpened and dull, and keep the surface yards clean. The foreman who orders the material assists the cager in unloading underground if necessary. The cager, besides handling supplies, acts as pumpman. Even though he had time, therefore, to handle the extra supplies for shaft sinking, it would have increased the operating expense if the muck from sinking had been hoisted on day shift, inasmuch as the skip is not suitable for handling miscellaneous material as safely as this can be done with the cage.

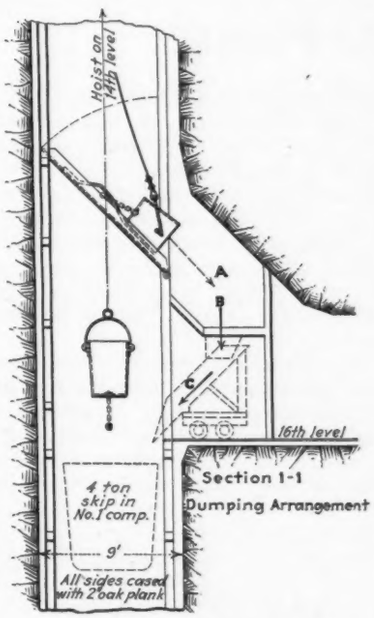


Fig. 1—Scheme for dumping sinking bucket at McPherson shaft

Mechanical details were planned to insure the greatest safety. Instructions were provided, as well as inspection to insure that they were observed. A general foreman and three capable working leaders were selected. Other members of the crew were taken from surplus trammers and timbermen or employed as muckers. Three crews were organized on the basis of the wage-scale prevailing and output per man on other similar jobs. The cycle of operations included three shifts: one for drilling and blasting, one for mucking, and the third for timbering.

Details of the drill shift as to time, duties, personnel, and wages are as follows:

Drill shift—11 p.m. to 7 a.m.
Duties: To drill and blast round.
Crew:
1 working leader @ $5.88.
3 drillers @ $4.48.
1 underground hoist engineer @ $3.88.

Electric blasting was used, the power line being equipped with a safety switch and also a two-way open switch for shorting the lead line. Exploders were made up at the surface exploder magazine. All blasting caps were tested by galvanometer. Seven delays were made from igniters and thoroughly waterproofed with shellac. These exploders were carried to the job in a small box having a section for each delay. A sufficient number of each for blasting a round was delivered daily. Any unused exploders were returned. This extra precaution is worth while. On account of the water to be encountered, a gelatin dynamite was selected. Drilling was done with four Type S49 jackhammers using $\frac{7}{8}$-in. hexagon steel. The average footage drilled was about 140, which was easily completed in time to charge and blast.

The details of the timber shift are as follows:

Timber shift—7 a.m. to 3 p.m.
Duties: To keep timber up with sinking (maximum distance allowed 20 ft.). To take loose ground down and make the shaft safe for the mucking crew.

Crew:
1 working leader @ $4.92.
3 timbermen @ $4.08.
1 underground hoist engineer @ $3.88.
Surface help chargeable to sinking:
1 hoist engineer @ $4.72.
1 surface laborer (general) @ $3.32.

Timber sets were swung by $1\frac{1}{4}$-in. rods at 5-ft. centers from the bearing timbers under the pentice.

The details of the mucking shift are as follows:

Mucking shift—3 p.m. to 11 p.m.
Duties: To muck out completely for drilling.

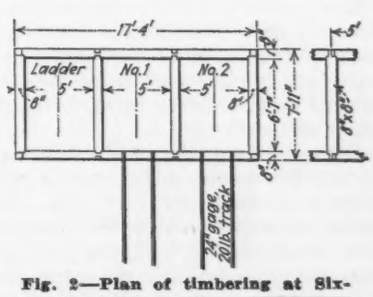


Fig. 2—Plan of timbering at Sixteenth level station, McPherson shaft

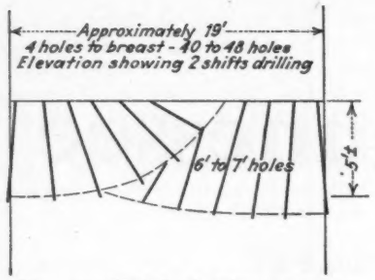


Fig. 3 — Sketch showing arrangement of holes in drilling, McPherson shaft

Crew:
1 working leader @ $4.92.
3 muckers @ $4.16.
1 underground lander @ $3.64.
1 underground hoist engineer @ $3.88.

Using a 25-hp. electric hoist and a ¾-in. non-twist cable, this four-man mucking crew loaded 393 cu.ft. per shift into an 8-cu.ft. bucket equipped with a chain and steel ball (as illustrated) for dumping. This method of dumping was selected as insuring positive protection from falling rock as well as speed in operation. The door is operated by an air jack from the loading level. All muck passes through two chutes to a portable chute which delivers into No. 1 skip, illustrated by the course *A-B-C* (Fig. 1). The advantages of this portable chute are evident. Bin capacity on surface was sufficient for a full shift's muck, which made it possible to dispose of the muck on day shift, using the regular surface crew, without additional cost. This muck was conveyed from the bin up an incline track by a small hoist in a 4-ton car. The car was automatically dumped by a diagonal block that tripped the door latch, the car returning by gravity. Emptying the bin required the services of one man about an hour each day.

Each shift's work was laid out as a task, with overtime if more than a shift were needed to complete the job. Members of the drill and mucking crews received a bonus of $2 per foot for footage exceeding a 2-ft. daily average for a month.

Results of shaft sinking for the month of October, 1929, by the scheme outlined were as follows:

Total footage (25 days worked), feet	57
Labor cost per foot (including $14 bonus)	$41.02
Material (excluding explosives)	14.63
Explosives	5.80
Air drill expense and power	4.09
Total cost per foot	$65.14
Average number of cubic feet of material broken and handled per man-shift (24 hours—19 men including foreman)	20.7
Cubic feet broken per pound of dynamite	4.3

The work, including all preparation, was completed without loss of time or minor accidents. No time was lost from powder sickness or bad air, inasmuch as the mucking crew followed the timber crew, thus allowing a lapse of eight hours between blasting and work in the bottom of the shaft. A saving of $50 per foot was realized over the cost of previous work and at the same time the sinking crew was satisfied, this without inconvenience to the mine operation.

Acid-Proof Pump for Small-Scale Plant

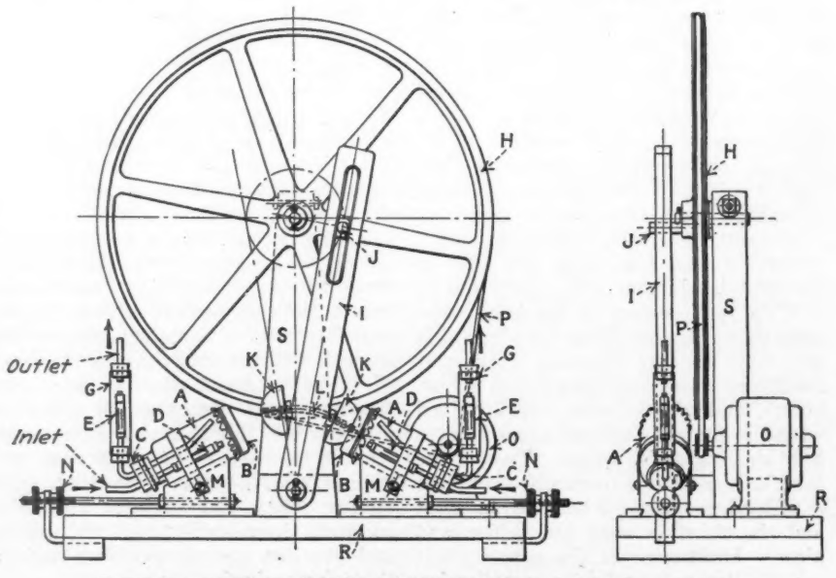
IN SETTING up small-scale apparatus in the laboratory for the first stage in semi-works development of a product, a small pump is often needed to circulate or feed accurately small quantities of liquid. According to H. L. Glaze, in *Chemical and Metallurgical Engineering*, such a pump cannot be purchased. The accompanying sketch shows the construction of one form of pump he has used for several months in circulating strong sulphur dioxide solution.

The equipment used for operating the diaphragms was easily constructed from materials at hand, and the mechanism serves satisfactorily. Cylinders, *A*, were made from 4-oz. wide-mouth bottles by cutting off the bottoms about ¼ in. up, and grinding the rough edges of the glass to prevent cutting the rubber diaphragms. The diaphragms, *B*, were made of pieces of old balloon inner tubes stretched over the open bottoms of the bottles and securely fastened with several wraps of strong twine, tightly tied. This operation takes four hands, two to stretch the rubber and two to tie it. Rubber stoppers, *C*, each having two holes, were used in the necks of the bottles, and were held in place with twine "bridles" secured around the necks of the bottles under the beads.

Bunsen valves, *D* and *E*, were made of heavy vacuum rubber tubing with three razor-blade slits or gills. The valves were stoppered at the free ends with short sections of glass rod, and both the stoppers and the connecting glass tubing were securely tied to the rubber with twine. Outlet valves, *E*, were inclosed in ¾-in.-bore glass tubing, *G*, with rubber stoppers tightly "bridled." The drive wheel, *H*, was salvaged from an old sewing machine. A lever, *I*, was made of hardwood, the slot for the crank pin, *J*, being lined with brass. Plungers, *K*, which press on the diaphragms, were rubber stoppers ground into the shape shown, and were simply screwed onto the threaded stud, *L*, running through the lever, *I*.

Wooden blocks, *M*, serve as adjustable mountings for the cylinders, and the amount pumped per stroke may be regulated by the knurled hand wheels, *N*, at each end. This adjustment is delicate and ranges from one drop to several cubic centimeters. The pump will develop about 10 ft. of water head and will suck several feet, depending upon the strength of the diaphragms; the heavier and the tighter the rubber, the greater the vacuum developed. The motor, *O*, was a small one of the split-phase type running at 1,800 r.p.m. on 60 cycles. It carried a ¾-in. pulley with a ¼-in. round belt, *P*. The whole mechanism was mounted upon a wooden base, *R*, with a wooden support, *S*, screwed on to carry the drive wheel.

The laboratory junk box can be made to yield most of the parts required for the pump. Its details of construction are easily variable to suit individual facilities. Its size, for instance, can be considerably increased or decreased without materially altering the design. The two cylinders are separately adjustable, so the pump may be used to handle two different fluids.



Pump for one or two liquids, suitable for semi-pilot-plant operation

Copper Production and Consumption

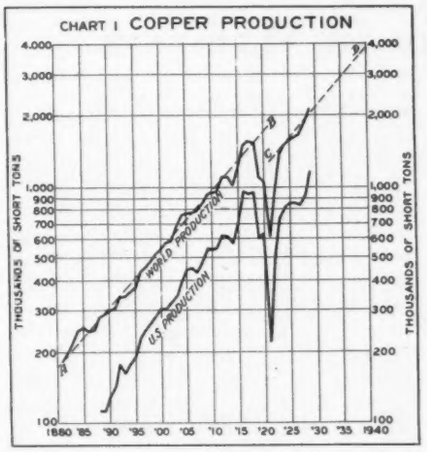
IN DISCUSSING the world copper situation a difference of opinion exists as to whether there is over-production or under-consumption. This is an important distinction and ought to be, and I believe easily can be settled. The natural definition of overproduction is production of more than the market requires. Under-consumption needs a specific definition, and I take it to be the consumption of less than normal. The problem is to determine what is the normal copper consumption of the world. I believe that the accompanying chart definitely and accurately establishes a trend line of future normal expectancy of annual world consumption from which we may with some assurance say that there is under-consumption if the actual consumption falls below this trend line. If the actual consumption is above this trend line, that is the good luck of the copper industry.

World Consumption of Copper

Over a long period of years consumption and production of copper must necessarily be equal. During the last fifty years, since 1880, the world production of copper, and hence the consumption, has shown a constant average cumulative increase of 6 per cent annually, and nothing but the World War has materially changed this trend. This is shown graphically in the chart, the straight line *A-B* being the trend line which the actual production curve closely approaches. This chart is plotted on a semi-logarithmic scale on which a straight line trend indicates the annual rate of increase. There is much interesting information to be read from this chart.

The first striking thing is the regularity of the world production curve. The variations from the trend line *A-B*, the normal average, are relatively small up to the outbreak of the war. This pre-war regularity which marks the steady world progress of the industry over such a long period is surprising when it is considered that the period covers that of the birth and development of electric lighting, the heyday of the suburban trolley development and its decline, the development of the automobile industry from zero to the second largest consumer of copper, the electrification of railroads, the invention of radio, and the greatest development of industry in the world's history; the discovery of the world's greatest copper mines, phenomenal advances in metallurgy and in the operating efficiency of large tonnage

CHART 1 COPPER PRODUCTION



production; and many periods of copper prices above the average, when the much-talked-of substitution of other metals would be stimulated, if high price copper does stimulate substitution; and many periods of low-price copper which would be expected to stimulate the wider use for copper if that theory is correct, but to neither of which theories I subscribe.

This period has seen at work all the factors, good and bad, of which only a few have been given that affect copper. Yet this old world has plodded steadily along on a 6 per cent annual rate of increase in consumption and production.

Trend Is Constant

Nothing but the World War made any material change in this trend line in fifty years. The curve shows the falling off in production in 1914, the first year of the war, when the whole world was so stunned that business judgment failed to realize the situation. This was followed by peak production to keep up with war demands, and then by great decrease in production and consumption in the post-war period, culminating in the grave industrial depression of 1921, so strikingly indicated by the chart.

Since for fifty years, the most progressive half century in the world's history, no factor except the World War materially affected the steadily increasing consumption of copper, it is logically sound to assume, barring another cataclysm of like proportions, that the world will continue at the same rate as before, at least for a decade or two, which is the important period right now, because it is during the next decade that the African coppers will come into production with new tonnage perhaps equivalent to 25 per cent of the world's present output.

Post-War Trend Shows Same Increase From New Starting Point

It is obvious that owing to the war disruption of economic life throughout the world post-war computations cannot be made from a pre-war base. This is evident not only from the curve, but also from a consideration of the facts. For four years the entire world bent its energies toward destruction, and world progress stopped. Whether we have yet recovered from the World War is beside the point here. Certain it is that we have to have a new post-war starting point.

The statistics of copper show that at the end of 1924 world consumption and production of copper were equal. I have taken this point on the curve as the proper starting point for the new trend line *C-D* at the same rate of 6 per cent annual increase. The curve shows that the period from 1925 to 1928 was below normal, tending to confirm the opinion of economic students that a post-war adjustment period still exists. The production figures for 1929 which are available at this time in 1930 indicate 2,136,000 tons. This puts the 1929 point of this curve above the trend line *C-D*.

Consumption figures are not yet available, but may be approximated as follows: Little, if any, increase has occurred in foreign stocks of copper during the year, but refined and blister stocks in North and South America increased 122,000 tons. This deducted from the production would give a consumption of 2,014,000 tons, to which must be added secondary copper, the total of which is not yet available. This

This is largely an abstract of the first of a series of three articles by Colonel Percy E. Barbour in "The Annalist" of March 7, 1930.

will locate the 1929 point in the curve practically on the trend line *C-D* which will then be between the 1928 point, when there was under-consumption, and the 1929 point, when there was over-production. This is as it should be. Therefore I feet that one may with perfect assurance accept the line *C-D* as the normal expectancy of copper production for the next decade, and may call consumption figures that fall below this line under-consumption.

Copper Resources

The curve of United States production on this chart has the same general trend as the world curve, but has greater annual variations because the United States production is more sensitive to local or temporary conditions.

The officially reported ore reserves of 21 of the important producers of the world, almost all for the year 1928, indicate resources of 49,892,996 tons of *copper metal,* or nearly fifty times the 1928 production of these same mines. If the world's copper resources were limited to these 21 deposits alone, and not one pound more copper was to be found in them than is estimated above, they would supply the world needs, at the estimated 6 per cent annual increase based on the 1924 consumption, for about eighteen years. That supply is actually in sight.

No one believes that the production of these mines will be limited to the amounts now estimated. Some might not be exceeded very much; others are sure to be greatly exceeded. These 21 mines in 1928 produced 1,003,866 tons of copper out of a total world production of 1,883,431 tons, or only 53 per cent of the total. It is not to be expected that the other 47 per cent of the production has similar potential reserves; but that they are large is certain from a consideration of a few individual camps not included in the above. Among the new districts there is the Sudbury district, in Canada, where the Frood mine is equipping to produce about 300,000,000 lb. of copper a year, with a life expectancy of over twenty-five years, perhaps fifty years. The mine is still in the development stage, with 120,000,000 tons of rich ore in sight. Then there are the Rhodesian coppers. The average grade of ore of the Katanga and six important Rhodesian coppers is over 4.9 per cent for 280,000,000 tons of ore. What the tonnage of lower-grade ore may be no one knows.

Hence, with eighteen years' supply of copper in sight in 53 per cent of the present producers, which will undoubtedly be increased by several years; with large but unreported reserves in the remaining 47 per cent of present producers; with the additional important present operating Rhodesian companies; with the vast ore reserves in the Congo and Rhodesia below 4.9 per cent not included; with Russia a potentially large producer, it seems perfectly obvious that there can be no shortage of copper for world needs within the next forty or fifty years.

U. S. and Foreign Production

From 1895 to 1928, with the single exception of 1921, when there was a serious business reaction, the United States has produced annually more than half of the world's copper.

In 1931 it is expected that the International Nickel Company will be ready with 200 to 300 million pounds of new production, Noranda with 50 to 100 million new production, and Flin Flon and Sherritt Gordon a year or so later with perhaps another 100 million. In other words, Canada within a year or two will add about 500,000,000 lb. of new production. This is equivalent to a new Utah Copper and a new Anaconda under normal production. This copper is produced contiguous to the United States across an imaginary geographical line with no tariff wall, and most of it should be produced at a cost much lower than the average United States cost. Its effect on United States production cannot be ignored. In 1932 Roan Antelope expects to add another 250,000,000 lb. of new production, and from then until 1940 the other South African coppers will be coming in, and at the end of the decade are expected to be producing at the rate of 1,000,000,000 lb. per annum.

Although the United States may be expected to produce a relatively smaller proportion of the total, it should not lose its dominating position in the world copper production, at least during the next decade or two.

Boring for Tin in Malaysia

METHODS employed in boring for tin in Malaysia were recently discussed by B. A. Hadley at a meeting of the Broken Hill, N. S. W., branch of the Australian Institute of Mining and Metallurgy. Bore sites, said Mr. Hadley, are situated at the corners of squares or rectangles and are three to twelve chains apart. Empire drilling outfits are used, accessory equipment including casing in 5-ft. lengths, 1-in. square screw-jointed iron rods in 10-ft. lengths, and a sand pump. A boring crew consists of eight laborers, one woman sample washer, and a tin dresser. Four of the laborers work at one time on a wooden platform erected at the bore site. The casing, bearing a protective shoe, and the sand pump attached to a length of rod on which are placed a number of dogs, are forced into the wash. The men throw the rod and pump upward, and, as this unit descends, put their whole weight onto the dogs, thus forcing the pump into the ground. Simultaneously, the other four men turn the casing by means of the four clamps fastened to it.

The sand pump is removed at intervals, usually for each five feet bored, and the contents are placed in a wooden tub. A measuring box of ½ cu.ft. capacity, 12x12x6 in. deep, with a nail three inches or halfway up the side, is then half filled with water to the three-inch mark. Into this box the drained sample is added, the amount of the sample being measured by the displacement of water. This method is generally used for clayey wash. The measured sample is next washed free of clay in a bucket, and the remainder of the sample again measured. From this second measurement is deduced the quantity of water required for satisfactory dredging. The woman sample washer then roughly concentrates the sample in a wooden dish or "dulang." This rough concentrate is placed in a sample tin, numbered, and given to a tin dresser, who makes the final concentration. A good dresser does not lose more than 10 per cent of the tin. The quantity of tin obtained is weighed on balances that read in ounces or in Valentine units. One Valentine unit represents, for a full box, one cattie per cubic yard, or 1⅓ lb.

One crew, under good conditions, can bore two 25-ft. holes per shift of 7½ hours. A depth of 110 ft. can be bored with an Empire drill. The final procedure in the boring of a property is check boring, which is done under the supervision of a different engineer and with another boring crew.

Amber Mining in Germany

Friedrich Prockat

Technische Hochschule, Berlin

Fig. 1 — Geographical position of the amber deposits of major importance

THE history of mining and exploiting German amber goes back to the Stone Age. Even the Roman emperors sent expeditions to the North to bring the precious substance down to Italy. In medieval times, amber commerce rose in economic importance together with the rise of the German order of knights, the Deutschen Ritter, who reserved the right to mine and deal in amber. After the ensuing centuries had seen the amber industry pass directly to the state or to the state's concessionaires, the complete undertaking was finally absorbed by the government in 1899.

Amber occurs in the Tertiary soapstone stratum in the northwest part of the East Prussian peninsula of Samland, near Königsberg. (See Fig. 1.) The best-known deposits are those of Palmnicken, which is still the site of the most extensive mining operations. The substance is the petrified rosin of evergreen trees, scientifically designated as the class of *Pinites succinifer*, and occurs in the most variegated forms, attesting to its solidification from a highly viscous state. The specific gravity of amber ranges from 1.05 to 1.15, as follows: pale clear, 1.05; pale clear yellowish, 1.06; clear red-brown, 1.07; milky yellow, 1.08; and black, 1.14. The substance has a hardness of 2 on the Mohr scale and occurs additionally in a translucent, cloudy condition, traceable to the presence of occlusions of tiny gas or liquid bubbles measuring 0.8 to 4 μ in diameter. In the clear amber, especially, are found different kinds of insects (ants, bugs, flies, spiders) as well as vegetal matter (wood splinters, pine needles, blossoms), all of which permit conclusions to be drawn with regard to the flora and fauna of the amber forests. As a result of its varying conditions of origin, amber has no strictly definite chemical composition; mean values for clear amber are 79 per cent C, 10.5 per cent H, and 10.5 per cent O_2, giving the formula $C_{10}H_{16}O$.

Fig. 2—Specimens of amber, with occluded insects

In East Prussia, the large blue-earth deposit containing the amber has a thickness of 6 to 8 m. It appears as a clayey, plastic sand, with a blue-gray or green-gray coloration that is produced by its glauconite content. The amber averages 1.6 to 1.7 kg. per cubic meter of blue earth. The stratum is almost horizontal, so that, owing to the decline in the sea bottom of the Baltic, the blue earth makes its submerged appearance at a distance of several hundred meters from the coast and many meters deep. Erosion of the bed of the sea by the Baltic, especially in spring and fall, loosens the blue earth at its submerged face, and causes the light amber to be washed ashore with the foam. For this reason amber could be collected in remote ages. About 10 per cent of the production now comes from coastal residues tossed up by the sea.

At the coast the blue earth is covered by about 36 m. of heavy Tertiary and diluvial strata; the ratio of blue earth to overburden is therefore about 6 to 1. The diluvial deposit appears as a gray marl containing sizable alluvial blocks, which prove a great obstacle to dredging with buckets.

Prior to 1923 the blue earth was obtained by shaft mining, and despite the slight depth of, say, 30 m., the loose

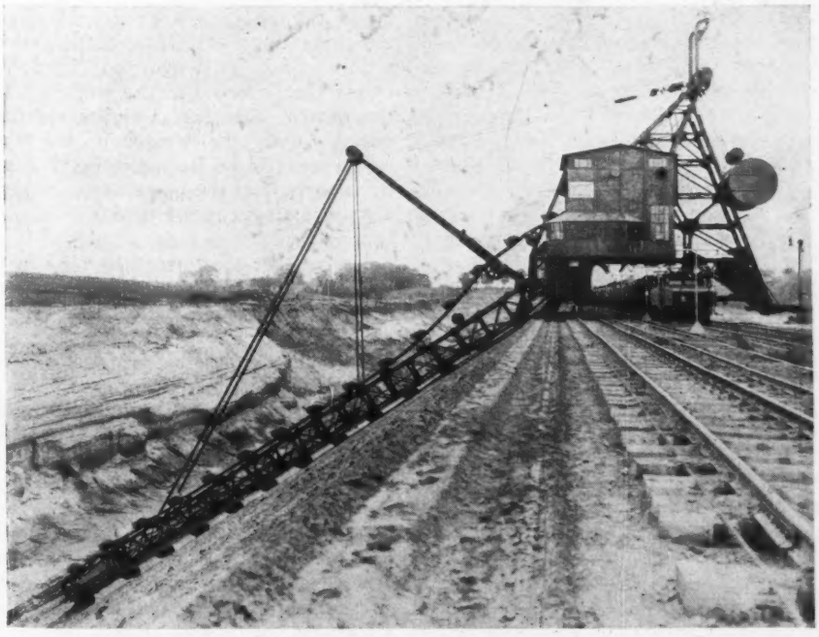


Fig. 3—Main dredging bank, using scraper and loading equipment delivering to electric haulage

Fig. 4—At Palmnicken, showing the three types of dredges used in amber mining: from left to right—the "variable," the "deep," and the "high"

overburden offered great difficulties because of its porosity to water flow and the occurrence of quicksand. After progress in mining had also impaired the secondary and buttressing operations because of the wavy formation of the deposits, open mining was decided on. To this end a main dredging bank was built in a new part of the property (Fig. 3) for removal of the upper layers. The equipment for this open mining was supplied by the Maschinenfabrik Buckau, R. Wolf, A. G., Magdeburg. A view of the site from the upper end of its incline is seen in Fig. 4.

A high bucket dredge with a capacity of 350 cu.m. and a bucket capacity of 400 l. serves to remove the diluvial marl. For the subsequent clayey Miocene sand, 20 m. thick, two deep bucket dredges of equal capacity and 30-m. working depth are used. Each of these, with a working weight of 180 tons, has a main motor of 225 hp. The first bucket conveyor has a motor of 175 hp.; the locomotional motor is 25 hp.

On a second, deeper bank, two variable dredges are set up, each having a capacity of 200 cu.m. per hour, with buckets of 200-l. capacity. These may be converted, within twelve minutes and without structural change, from a deep-dredging to a high-dredging conveyor, or vice versa. Thus the apparatus can meet varying conditions, and remove the sandy deposits lying above the blue earth or the blue earth itself, as is apparent from Fig. 5. Each of the variable dredges can excavate 7 to 8 m. high. The residue of the overburden on the blue earth is conveyed by tip carts, holding 5.3 cu.m., to a cleared section of the workings.

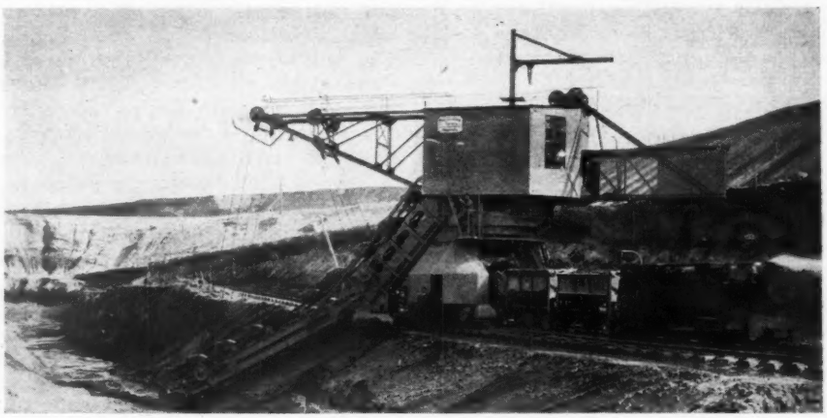


Fig. 5—Variable dredge operating as a deep dredge delivering to steam-locomotive train of cars

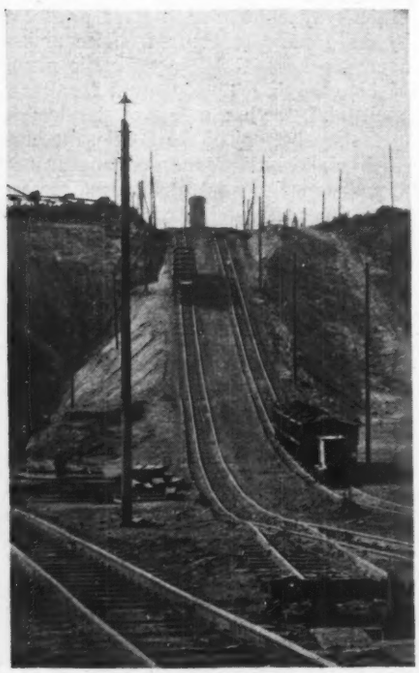


Fig. 6—Electrically operated haulage incline

In addition to these five 500-volt d.-c. bucket dredges, three spoon dredges, operated by steam, at hand for auxiliary needs, have a capacity of 2 cu.m. each spoon. For removing the overburden, cars holding 5.3 cu.m., made by Glaser & Pflaum, are used; but operations are being extended whereby large cars, holding 16 cu.m., and emptied by compressed air, will be used. Until a short time ago the overburden was removed by a flushing car and washed with water into the ocean. In this way, any particles of amber that had permeated into the next layer during the glacial period could be recovered. But, because of the relatively great distance, the overburden is now dumped back on the property by means of a mechanical dumper. This latter is a Buckau conveyor such as is successfully used in lignite mining, with a capacity of 8,000 cu.m. in 24 hours, and a power consumption of 100 hp.

The blue earth, bearing the amber, is raised to the surface on an incline in cars of 5.3 cu.m. capacity (Fig. 6). The latter, supplied by the Buckau Maschinenfabrik, are so constructed that, when a full load is hoisted on one track, an empty car descends to the workings on the other. The dead weights are balanced. Only the weight of the blue earth needs to be hauled. Fig. 7 is an interior view of the power house, where an alternating current of 3,000 volts is available.

For further treatment, the blue earth is transported to Palmnicken by means of electric locomotives. The cars are emptied over a grate in the so-called spray house, and the blue earth is pulped, with sea water under a pressure of six atmospheres, by the flushing methods familiar in the extraction of gold from sands. The larger amber pieces are collected by hand; the smaller ones flow on with the clay slurry, on which they float because of their low specific gravity—under 1.5. It is thus possible to remove the heavy material from the channel, as in coal technology, while the amber-bearing slurry flows on to a classifying drum, where the amber is segregated into different sizes. The

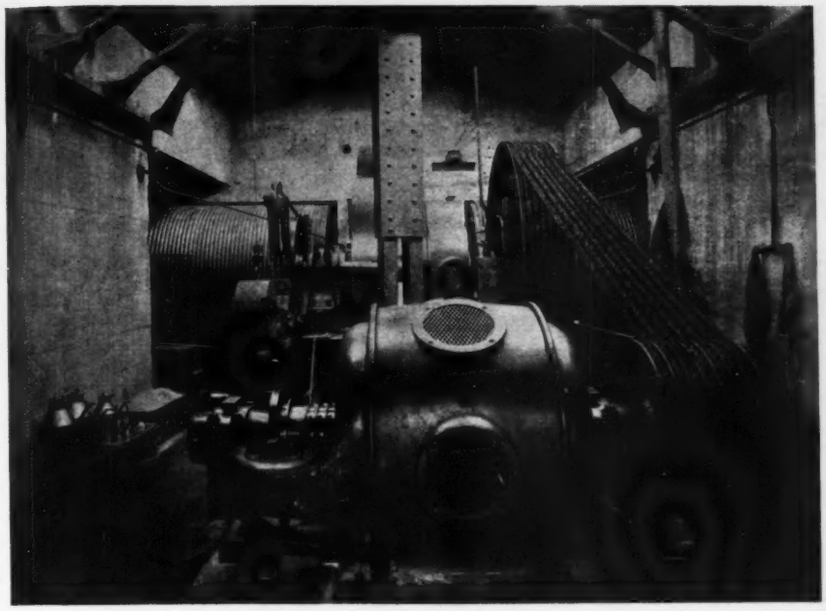


Fig. 7—Motor and hoist equipment operating the incline

larger pieces are cleaned of their crust in special wooden drums (Fig. 9), to which sand and soda solution are added. At the sorting, which is done at Königsberg, these are again beaten by hand, so that only clean amber will be sent to the market.

About 80 per cent of the total amber output is too small or unclean for direct consumption by the jewel and novelty

Fig. 8—Spraying the blue earth

trade. The less valuable grades are sorted by hand according to color, and used for pressed amber or secondary fused products. Although the application of mechanical sorting devices has been tried several times, it has not yet led to efficient results, because the differences in specific gravity are too slight. For pressed amber, small but clear and well-cleaned pieces are used. Careful warming and hydraulic pressure then permit the making of large homogeneous pieces of various shapes. The addition of minute quantities of color will also give the amber a special tint. This pressed amber, "ambroid," is then machined and fabricated in the same manner as natural amber.

After washing, the dirty and small pieces of amber (especially those under 13 mm.) are subjected to dry distillation in iron retorts in the smelting plant at Palmnicken. This produces 60 to 65 per cent amber colophony or resin, 15 to 20 per cent amber oil, and 2 per cent acid. The remainder represents loss as water, impurities, and volatile ethereal oils. The resinous, glistening colophony is the raw material for high-grade amber varnish; the oil is also used in the varnish industry, as well as in metal casting and in flotation; and the acid is used for pharmaceutical purposes and in the manufacture of rhodamine dyes.

Annual amber output of the Preussische Bergwerke u. Hütten-A.G., which is working the deposits, is about 500,000 kg., of which about 10 per cent is collected and fished up on the Baltic shore line and 90 per cent results from the large mining operation at Palmnicken. The latter represents the handling of 2,000,000 cu.m. of overburden and 250,000 cu.m. of blue earth. The personnel in Palmnicken comprises 600 to 700 men. In Königsberg 150 additional men are employed in sorting and pressing.

Fig. 9—Wooden drums in which the amber is cleaned

Power (for haulage, and so forth) is generated by the company in its own plant from upper Silesian coal. A transformer converts the 3,000-volt alternating current to 500 volts direct current, for the railway and dredges.

Fig. 10—Finishing room, where the amber is cut and prepared for commerce

A Simple System of Numbering Mine Workings

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THE identification of individual mine workings by names or numbers is essential for maintaining accounts, assay data, and geological records, as well as for use in operation of the mine. Although almost any title will serve to distinguish a certain place, often in larger mines the numbering system becomes unwieldly and troublesome. Wherever a definite system has been in use for more than a short period, changes are not advisable, because they would greatly complicate past records, but in new mines the early adoption of a simple and rational system of numbering the workings is good policy. This is particularly true in the present day, as more accurate records are kept than formerly and the numbers are therefore in more frequent use in both mine and office.

In many older mines the level workings are referred to by location, so that a given record might apply to the *first crosscut west off the Samson drift north, 300 level.* This designation is, of course, much too long for frequent clerical use and it loses its value if a new crosscut is driven west from the same Samson drift, south of the named crosscut. The method is somewhat improved by naming each place, as for instance, *Samson drift, Butte crosscut,* and *Idaho raise;* but it fails to designate the level elevation unless a prefix is used, such as in *300 Samson drift,* and it requires a multitude of proper names. An example of this extended type of reference may be found at the old Highland Boy mine, at Bingham, Utah, where the *CCSW-DW-CCS-5th Arizona-3 level* refers to the crosscut southwest off the drift west off the crosscut south from the Arizona stope at the fifth floor over the third level. This system resembles somewhat that of designating the working place by reference to the mine co-ordinates and elevation, which has been used at some mines. Both methods have the advantage of fixing the location of the place, but the designations are unwieldy and, where they must be used frequently in accounts, assay records, and on maps, this is a serious fault. The use of simple numbers for all mine workings is to be preferred, and these should indicate the level or elevation at which the place is located. An attempt to include the location of the place laterally in the mine usually results in too great complication.

At the Anaconda mines in Butte, Mont., working numbers for each mine are assigned in consecutive order on each level, as *2,601 Dr, 2,652 Xc,* and *2,699 Rs,* all on the 2,600-ft. level. Additional working places on this level are numbered *A-2,601* to *A-2,699,* then *B-2,601* to *B-2,699,* and so on. The location of the place must then be found by reference to the proper map. This method has the advantage of simplicity and provides each place in the mine with a brief designation which pertains to that place alone. The Utah Apex company, at Bingham, Utah, employs a similar method, but writes the level number in full, as *3,100-17 Dr,* and reserves for stopes all numbers which are divisible by five. In addition, a letter may be prefixed to indicate some section of the mine, and a second letter may be suffixed to indicate a branching orebody. Thus *L 2,300-10 B* would indicate a branch of 2,300-10 stope from 2,300 level in the Leadville section of the mine. The value of these additions is probably more than offset by loss of simplicity.

My own preference is to number working places by means of two numbers, the first number indicating the level and the second number referring to the particular place. The numbers should be used in consecutive order as new places are started on each level, whether they be raise, winze, drift, crosscut, or stope. Thus, *21-19* stope and *21-172* drive are from and on the 2,100 level, respectively. The numbers are brief, the method requires no changes if more than 99 working places are started on a given level, and the method is particularly applicable to the numbering of intermediate or sublevels. The latter cause considerable trouble in most systems of mine numbers.

At the Utah Delaware mine, Bingham, Utah, where intermediate and sublevel workings are frequent, these workings are usually numbered from the raise or winze off which they were driven, as illustrated in Fig. 1. This has the advantage of assisting any employee who is not entirely familiar with

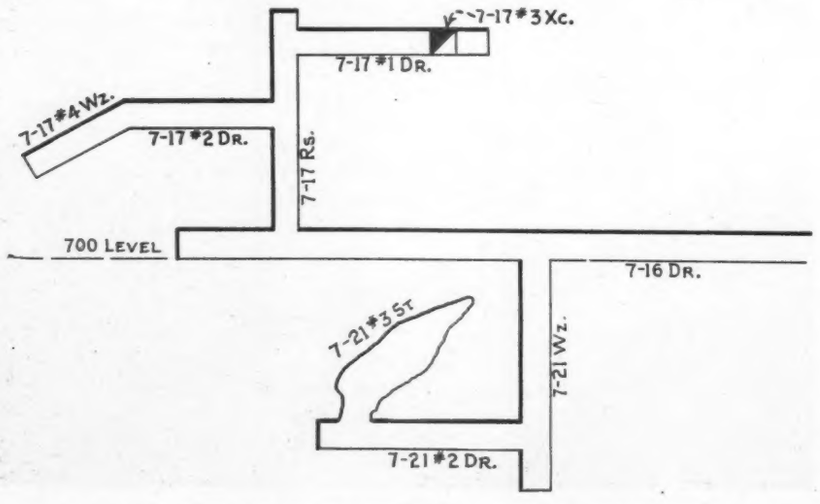

Fig. 1—Numbering system employed at the Utah Delaware mine

the mine to find the place by simply locating the raise or winze with a similar number. Offsetting this advantage is the fact that intermediate workings are often numbered from levels far below, and the number may become confusing, particularly if the intermediate grows to such proportions that the original raise is no longer important, or possibly not in use.

Fig. 2 illustrates two methods of numbering which I have applied to intermediate workings in different mines. Level workings, stopes, raises, and winzes are numbered by the simple method to which preference has just been given. Fig. 2 the same method is applied to intermediate workings between the 2,100 and 2,300 levels, whereby *21½-24 Dr.* is about the 2,150 level, the *22-15 Dr.* is about the 2,200 level, and *21¾-01 Dr.* is about the 2,175 level. By indicating the level to the nearest 25 ft., the depth position of the working is immediately brought to mind and no additional information bearing on location is attempted in this very simple system. In Fig. 2 the workings between the 2,300 and 2,500 levels are numbered by a method which is applicable to square-set mining methods. The stope floors are assigned letters from bottom to top in each lift, and intermediate headings are numbered and lettered to indicate the floor elevation above the next lower level. Thus, *25R-04 Dr.* is a drift off the eighteenth floor over the 2,500 level, *25H-07 Rs.* is a raise started from the eighth floor over the 2,500 level, and *25F-01 Xc.* is a crosscut off the sixth floor over the 2,500 level. The elevation of intermediate workings is thus shown by a relatively simple number, but one must remember that stope floors will usually be thought of as third or seventh rather than as the *C* or *G* floor. Of the two methods shown in Fig. 2, the first is preferred, because it introduces nothing new to the average employee and fixes in his mind the approximate elevation of the place.

Fig. 2—Methods of numbering intermediate workings

New Method of Assay for Gold in Cyanide Solutions

John N. Dixon
Kirkland Lake Gold Mining Co., Ltd.
Kirkland Lake, Ont.

FOR several years the Chiddy method of assaying gold cyanide solutions, as modified by F. Borzunski, has been used at the Kirkland Lake Gold Mines property in Ontario. This method, when carefully carried out, gives good results with fairly clean solutions, and with low-grade solutions, even when foul. But since changing from sodium cyanide to calcium cyanamide in the mill circuit, the results from Borzunski's method have not been reliable for the higher-grade solutions.

Much experimenting was done in an endeavor to obtain accurate results by a modification of Borzunski's method. The proportions of tartaric acid, lead acetate, and hydrochloric acid were varied. An addition of sodium cyanide was tried. The amount of zinc dust used was varied. Variations were also made in the time interval and the order in which the various reagents were added. Furthermore, the temperature at which the various operations were carried out was varied. But consistently correct results were impossible of attainment. Typically, in two solutions assayed at the same time and given precisely the same treatment, and both giving tough, coherent sponges, one checked 60c. low against an evaporation assay, and the other, $1 low. Finally, the method was abandoned, and I devised the following new method that gives consistent, exact checks against evaporation assays.

Place 20 assay tons of the solution in a 1,000 c.c. Erlenmeyer flask. Add about 1 c.c. saturated lead nitrate solution and about 15 c.c. saturated sodium cyanide solution. Shake and add about 2 grams zinc dust. Close the flask with a rubber stopper and shake vigorously until the lead precipitate is well formed and settles quickly. This takes from one to three minutes. Sometimes the solution is left perfectly clear, but more often a slight, white flocculent precipitate is left in suspension. This goes out with the solution and does no harm.

Take a piece of lead foil and put it in a 2½ in. porcelain evaporating dish, in such a way as to form a lining for it. Invert the flask in the lead-lined dish and allow the lead precipitate to settle. Carefully allow air to enter the flask until the evaporating dish is full of solution. A rack should be made with as many circular holes open at the front as there are assays to be made at one time. The holes should be of such a size and the rack at such a height that the inverted flasks are held with their mouths just below the top edges of the evaporating dishes.

After the lead has settled, remove the flask quickly from the evaporating dish and allow the solution to run to waste. Decant the solution from the lead and melt the foil with the precipitate in a size "D" Battersea fireclay crucible with a high-litharge flux. If a heavy borax glass cover is used, the precipitate need not be dried previous to melting. We use about 60 grams standard mine-sample flux, of the following composition: Litharge, 60 parts; borax glass, 15 parts; soda ash, 22 parts; flour, 2 parts. This, with lead from the foil and the precipitate, gives a soft, clean button of about 20 grams' weight.

Although this method requires an extra furnace operation, the wet part of the assay is so shortened that the total time for the assay and the assayer's time required for the manipulations are both lessened, compared with the Chiddy method. The assay is finished in the ordinary way.

SIXTY YEARS AGO

1870-1930

☞PROFIT-SHARING—Apparently one of the first companies in the United States to institute any kind of profit-sharing scheme with its employees was A. S. Cameron & Company, then the largest manufacturers of steam pumps in the country, having 110 men employed on that specialty in January, 1870. As our readers know, Cameron pumps are still made, but nowadays by the Ingersoll-Rand Company. The Cameron scheme was to distribute 10 per cent of its annual profits in proportion to the wages earned during the year by each employee. That the company expected to get value received is made plain by the conditions of the offer: "Bear in mind that this distribution of profits will only be made on condition that your increased efforts entitle you to it. Should the rule operate to our advantage, in relieving us from following up the leaks and the loafers, we will continue it; not otherwise . . . . If you do not appreciate the offer, we will consider you untrue to yourselves, to your families, and to your fellow workmen at large, and will take pains to make the fact known. What we expect in return is, that you will work earnestly and faithfully, and see that neither time nor material is wasted; that you will point out to us any labor-saving item, or other source of economy that may suggest itself to you. And above all, we expect that those who do not enter into the spirit of this matter will be pointed out to us for prompt dismissal." It is evident that employers spoke much plainer in those days than now.

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☞AND ROEBLING WIRE ROPE PERSISTS—Few of the ads carry names that are familiar today, but among those that do is one for wire rope, manufactured by John A. Roebling, Trenton, N. J.

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☞THE JAPANESE INVASION—Our readers on the Coast will be interested to know that some attention was given to the problem of Japanese cheap labor as early as 1870, though the Japanese colony at that time apparently consisted of but seven women and fourteen men. They lived at Gold Hill, El Dorado County, formerly one of the richest mining regions of the state, but at that time comparatively deserted, and they were starting what was then thought to have the possibility of "the addition of millions of dollars to our national wealth"—namely, the growing of tea. Mr. Schnell, who supervised the Japanese colony, was convinced that "the problem of tea culture in California is solved, and there is no longer doubt but we can raise as good teas here as are produced in China and Japan." However, the industry was not expected to grow very fast, apparently, for we are assured that "all hopes or fears of a large Japanese immigration to spring from this experiment may as well be at once dismissed." We hesitate to say that the tea industry in California must have turned out to be a complete flop, lest some indignant readers write in to say that the best tea in the world is grown there.

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☞WHEN GEOLOGY WAS YOUNG—Not long ago while looking at a geological map of northern Canada—up where the areal geology is aerial—we were struck by the apparent sameness of the formations in much of the country, which condition will no doubt change when more two-legged work is done. Six decades ago, however, the geological character of much of our own country was none too well developed. Early in 1870, for instance, a finely executed geological map was published, including most of Wyoming, Montana, and Idaho. But west of the Rocky Mountains, said Dr. Raymond at that time, "the map is wanting in geological details, the whole country being 'laid in' with an agreeable salmon color which denotes, as the text informs us, 'granitic, metamorphic, and basaltic' formations. This only needs an 'etc.' to be quite accurate."

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☞THE STETEFELDT FURNACE—Multiple-hearth roasters have largely displaced all other kinds, but in 1870 the Stetefeldt shaft furnace was a novelty. Charles A. Stetefeldt discovered that silver ores, no matter in which combination the silver occurs, mixed with salt, are completely chloridized if they fall against a current of hot air rising in a shaft with no obstructions whatever to check the fall of the ore particles. His furnace for this purpose was invented in 1867 at Austin, Nev., and first introduced for regular working at the mill of the Nevada Silver Mining Company, near Reno, Nev., in October, 1869. It is described in some detail in *E.&M.J.* of Feb. 15, 1870, and consists of a shaft made of common brick through which the ore and salt mixture falls from the charging device at the top. Heated air from grates is admitted near the bottom, and near the top is an outlet for the gases, with subsequent provision for settlement of the dust. Three to four per cent of salt was used for low-grade ores, and 6 per cent for rich ores, about 90 per cent chlorination being effected, the silver then being in condition for amalgamation. Two cords of wood was used for roasting 12 to 15 tons of ore a day. Work of this kind is not entirely extinct, for only recently zinc concentrate has been given a flash roast, at least experimentally, in a shaft furnace with no fuel at all required after the furnace has once been heated and with improved metallurgical results in the subsequent leaching process.

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☞BEFORE AIR BRAKES WERE INVENTED — The leading article in *E.&M.J.* of March 8, 1870, reminds us of half-forgotten practice in railroading that survives only as an emergency measure:

"The attainment of high speeds on modern railroads lends more and more importance to the question how trains are to be stopped against the frightful momentum they acquire. In England the methods adopted are quite clumsy. The engineer shuts off steam nearly a mile before arriving at a station. . . . If all the brakemen are at their posts, and simultaneously apply the brakes, it is possible to stop an American passenger train in 600 or 800 ft. as a minimum. But in cases requiring instant action, too much time is lost by the brakeman in getting to the brakes, taking up the slack of the chain, and operating one brake after another. An average loss of 30 seconds in this way would make a loss of a quarter mile in stopping a fast train. Now how many cases are there in which this quarter-mile means awful destruction and death!"

However, a certain measure of safety was insured by the use of the Creamer safety brake, which was wound up against a stiff spring and could be released by pulling a cord in case of emergency. Two years later, in 1872, George Westinghouse invented the air brake.

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☞A USEFUL FORM FOR REPLY—In the "Answers to Correspondents" in the March 15, 1870, issue of *E.&M.J.* is a reply to one "J. J. G.," of Waverly, Ohio, that we are thinking of having mimeographed for sending to those who continue to write us on the same subject in 1930. The question is not stated, but it can be imagined from the reply: "We are not in a position to undertake any negotiations of the character you propose. If the affair is as promising as you represent, parties nearer home should be willing to take hold of it."

E. H. R.

Personal Notes

A. S. DWIGHT

Col. **A. S. Dwight,** president of Dwight & Lloyd, and a director of several other corporations, was married on March 14, at Hartford, Conn., to **Mrs. Anne Howard Chapin,** of New York and Hartford.

Charles Hardy sailed from New York on March 14 for a stay in Europe of several weeks.

Guy C. Riddell returned to New York early in March after a month's absence in Venezuela.

Heath Steele and **Bernard Zimmer** have been elected vice-presidents of American Metal.

Lester W. Strauss has returned to New York City after several months in Tennessee and North Carolina.

Joseph I. Vorobreff, manager of mine operations of the Polymetal Trust of the Soviet Republic, is visiting Western mining camps.

J. V. Danko, formerly with Crown Mines, Ltd., has joined the geological staff of Loangwa, Ltd., Broken Hill, Northern Rhodesia.

Frederick Laist, general metallurgical manager for Anaconda Copper Mining, has returned from a trip of inspection of the company's Western plants.

Foster S. Naething has been appointed manager at East St. Louis for Evans-Wallower Zinc, and has been elected a vice-president of Evans-Wallower Lead.

Robert Goodwin, superintendent of Bingham Metals, Bingham, Utah, will succeed **F. E. Turner,** who retired recently, as mine superintendent of Ohio Copper.

D. C. MacKallor has been elected secretary, treasurer, and a director of Consolidated Lead & Zinc, in the Tri-State district, to succeed **Vernon Jones,** who resigned recently.

Cornelius F. Kelley, president of Anaconda Copper Mining, will deliver the Class Day address at the Michigan College of Mining and Technology, at Houghton on April 17.

Hans T. F. Lundberg, of the Swedish American Prospecting Company, discussed geophysical prospecting before a recent meeting of the San Francisco section of the A.I.M.E.

A. D. Bryant, mining engineer with Cerro de Pasco, stationed in Peru, arrived in New York on March 3 on a vacation trip, and left early in March by air transport for Los Angeles.

Harry R. Wilson, metallurgist for Hercules Mining, near Wallace, Idaho, has resigned and left in March for Russia, to accept a position as consulting metallurgist for the Soviet government.

A. W. Newberry, mining engineer, of New York, addressed the Crucible Club of the Mackay School of Mines, at Reno, Nev., on March 18. He discussed his experience in South African mining fields.

A. Broughton Edge, who has been in Australia for the last two years in charge of the Imperial Geophysical Experimental Survey, has returned to England, and expects to leave shortly for Northern Rhodesia.

W. A. Wood, consulting engineer, who constructed the Great Falls plant of Anaconda Wire & Cable, left early in March for Russia, to advise the Soviet government on problems connected with the fabrication of non-ferrous metals.

M. H. Merriss, formerly with American Smelting & Refining, at Baltimore, Md., and later with Nichols Copper, at Laurel Hill, N. Y., has joined the technical staff of the du Pont Ammonia Corporation, with headquarters at Wilmington, Del.

F. G. Bacon, assistant mill superintendent of the Midvale plant of U. S. Smelting, Refining & Mining, has accepted a position as research metallurgist for El Potosi Mining, in Chihuahua, Mexico. He will leave for his new post on April 1.

Walter W. Bradley, State Mineralogist of California, has returned from New York to San Francisco via Panama. He attended the A.I.M.E. meeting in New York, and a conference of state geologists with Dr. **George Otis Smith,** Director of the U. S. Geological Survey.

Dr. **Ernest R. Lilley,** of New York University, has been awarded the John Simon Guggenheim fellowship entitling him to study abroad for one year. His study will concern itself with political and commercial policy in the development of natural resources in Europe.

Victor Dolmage has been elected chairman of the British Columbia section of the Canadian Institute of Mining and Metallurgy. The members of the council for the coming year are: **George A. Clothier, R. R. Hedley, B. B. Knowles, P. W. Racey,** and **C. W. Villiers.**

C. H. Brandes, formerly chief mechanical engineer and general purchasing agent of American Metal, and subsequently vice-president of Metallurgical & Chemical Corporation, and International Process & Engineering Corporation, has joined the staff of Western Precipitation Company, with headquarters in New York.

G. Keith Allen, mining engineer with Rhodesia Broken Hill Development, Ltd., sailed from New York for London on March 15. Mr. Allen, who has been visiting copper mining properties in the United States and Mexico during the last seven months, will spend a short time in England, and then proceed to Northern Rhodesia.

John W. Newton, formerly general superintendent of the Oklahoma properties of Commerce Mining & Royalty, has been advanced to an executive position with the company, and **F. H. Gartung,** superintendent of the Kansas properties, has been promoted to general superintendent of all operations. He has appointed **Gil Burke** as general mine foreman in the first move of a general reorganization of the company's operations.

Frederick Burbidge, of Wallace, Idaho, has resigned as general manager of Federal Mining & Smelting, a position he has held for fourteen years. His resignation is effective May 1, when he plans to make his home in Spokane, and retire from business. Mr. Burbidge has been a prominent figure in the Coeur d'Alene district of Idaho for more than forty years. He first went to the district in 1888 to establish an ore-sampling plant. Later he was connected with Bunker Hill & Sullivan for eight years, at the end of which period he was general manager, and he was also manager of Helen-Frisco Mining before it was sold to Federal M. & S.

OBITUARY

Frank A. Wilder, professor of geology at Grinnell College, Iowa, and founder of the Southern Gypsum Company, died on March 7, at Abington, Va. He was 68 years of age.

H. A. C. Jenison, mining engineer with the Guaranty Company of New York, and formerly with the U. S. Bureau of Mines for many years, died in New York on Feb. 28.

Eugene H. Teats, retired mine promoter, of Denver, died at his home early in March. Mr. Teats, who in his earlier days was active in the mining industry in Colorado and Dutch Guiana, was 82 years old.

Morris Pierce, shift boss for Calumet & Arizona, at Bisbee, Ariz., died of heart disease recently while at work on the 1,200 level, near the Gardner shaft. He was 37 years old, and is survived by his widow and several children.

Ernst F. Eurich, retired mining engineer, of Montclair, N. J., and New York City, died in a hospital in Utica, N. Y., following an operation. He was 82 years of age, and a graduate of the College of the City of New York, class of 1866.

Claude E. Siebenthal, who had been connected with the U. S. Geological Survey for nearly 30 years, died on March 1, in Washington. He was born in Indiana, in 1869, and was of Swiss descent. Before joining the U. S. Geological Survey, Mr. Siebenthal had served with the Arkansas and Indiana geological surveys. He was at one time an instructor of geology at Indiana University.

Edward J. Lavino, chairman of E. J. Lavino & Company, producer of ferromanganese, died in Philadelphia, early in March. He was born in 1852, in Smyrna, Turkey, where his father was agent for the Dutch East Indies Company, and educated in Belgium. After a brief experience with the Dutch East Indies Company, he came to the United States, and in 1887 established himself in Philadelphia as an importer of manganese and chrome ores and alloys.

Comment and Criticism

Aërial Photography and Topographic Mapping

To the Editor of "E. & M.J.":

I have just read with interest an editorial in your issue of March 8 on "Progress of Topographical Mapping in the United States." All of us who have frequent occasion to use the U. S. Geological Survey maps must, at times, have experienced a feeling of annoyance on learning that the particular area in which we are interested is not yet surveyed. To complete the topographical map of the United States by the method now in use will require a great many years—so many years that, unless the personnel is considerably increased, a large number of us will not live to see the finished work. A new method, however, is now available to the government—that of aërial photography, with suitable ground controls. It is an accurate method, eliminating the personal equation to a great extent. If pursued on a large scale, I believe the cost will not greatly exceed that of present surveys. The principal advantage of aërial mapping lies, of course, in the rapidity with which it may be done.

Cannot our legislators be induced to make the appropriation necessary for a thorough trial of aërial surveying, to the end that we may see the topographic map of the United States completed within a reasonable time, and a part of the talent and energy of the U. S. Geological Survey released for more advanced work?

A. W. NEWBERRY.

New York, N. Y.

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Shaft Plumbing With Two Wires in One Shaft

To the Editor of "E.&M.J.":

Years of experience have shown that the main trouble in a shaft plumbing job is only the difficulty to fix exactly the corresponding points (co-ordinates) underground and on the surface, caused by the swinging of the wires. The difference between tape and angular measurements remains generally within limits so narrow that it can be neglected.

The co-ordinates underground may also be located, within reasonable limits, by minute observations of the swinging wires, using the Schmidt scale. If the distance between the instrument and the next wire is less than five meters, the lining of the instrument can be done with the exactness of 15 sec., a result obtainable without difficulties.

Mr. Fritz Turban proposes a method in *Engineering and Mining Journal* of Nov. 9 that is no more than a control of the main-shaft plumbing job. But whereas this method of control reaches by no means the exactness obtained first, its value to the practical surveyor seems to be doubtful.

P. ERIMESCO.

Freiberg, Saxony.

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Research on Silver Alloys

To the Editor of "E.&M.J.":

The slump in the price of silver is naturally a serious matter for the silver mines, and, from what one can learn of the silver market situation, there does not appear to be much likelihood of an improvement in price, for a time at least, unless some unexpected development takes place to stimulate demand.

Research has solved problems that were pronounced impossible of solution. For instance, the paint and varnish interests said that it was impossible to finish automobile bodies in less than twenty-four days; the silverware merchant, on the other hand, said that the lacquer he employed dried too quickly to be used for automobile finishing; but today "Duco" is in common use, and both opinions proved to be wrong. Research needs no brief, however, because so many developments have taken place as a result of it.

A prize of £5,000, to be awarded to the person discovering a new use for mercury that will increase the world annual consumption by 5,000 flasks, was established recently by Mercurio Europeo, at Lausanne, Switzerland. It strikes me that the silver producers might overcome their price difficulties by offering a substantial award to anyone perfecting an untarnishable sterling silver alloy (925 fine), and possibly a second lesser award to anyone discovering a new industrial use for silver. For instance, if a silver alloy were discovered that presented unquestionable advantages over any other material, and, as a result, a better automobile could be made, the consumption of such an alloy would be enormous, even if only a few ounces were used in each new car.

I know that considerable research has already been done on silver alloys, but that does not mean that the riddle can't be solved. If this suggested research should be successful, and one or both problems should be solved, the demand for silver would be increased greatly, probably to a point where consumption in the United States would exceed production. When that point is reached, and consumption does exceed production, one of the great arguments used by members of Congress against a tariff on silver will be completely silenced.

The suggestion for an award for research work on silver alloys is not original with me. The American Silver Producers' Association and probably others have considered it from time to time, but, owing to the present price trend and its serious effect on the industry, the thought should have immediate and serious reconsideration. Furthermore, although the Mercurio Europeo offer of an award to research men of the world is inspiring, the problem submitted therein is, in my opinion, much more difficult than the silver research problem.

In closing, I wish to commend to all those concerned with the problem your editorial "Stimulating the Demand for Silver," which appeared in the Jan. 23 issue. In connection with the uses of silver, the fact that it is one of the few metals occurring frequently in the native state testifies to its industrial fitness. A reasonably priced alloy containing silver and possessing a high degree of indestructibility when buried in soil would be in great demand for innumerable uses.

J. A. FULTON.

Mackay School of Mines,
Reno, Nev.

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Exposing Questionable Promotions

To the Editor of "E.&M.J.:"

I believe that *Engineering and Mining Journal*, in publishing comments on questionable promotions in the mining industry, accomplishes a great amount of good. In particular, the editorial in the Nov. 2 issue, on "Secret Processes and the Making of Vast Profits," interested me, because a short time after reading it I was passing through Cisco, Utah, on an examination trip, and heard the company in question bitterly criticized by freighters and miners who had shipped ore to Denver and were disappointed at the absence of pay therefor.

The company also shipped ore from New Castle, Colo., to the amount of two cars, the labor cost of producing which was more than $50 per ton. Unpaid bills in that section are a fine testimonial to the results of the secret process. I note that the freighting cost of the ore in Utah was $40 per ton to the railroad, which compares poorly with the estimated cost shown in the prospectus, of $32.70 for mining, treatment, refining, and haulage. But such details rarely bother the promoters of a secret process.

One town is much interested in a lead-zinc prospect on which another company is beating the same tom-tom of easy profits by the use of a wonderful process. There must be some favorable condition in Denver for the breeding of promotions of this character. Perhaps the "mining psychology," as the Denver newspapers call it, has gone slightly sour.

ENGINEER.

Denver, Colo.

INDUSTRIAL PROGRESS

Chain Feeder Successful at Horne Mine in Underground Chute

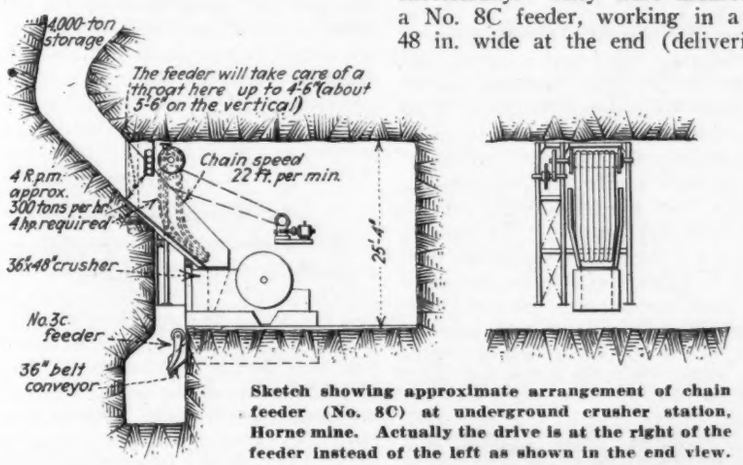
THE possibility of controlling the flow of ore through a large bin or chute opening by means of a curtain of endless chains that, hanging from a drum above, rest against the ore stream in the chute and by their weight and their forward speed cause the stream to move at some pre-determined rate (or keep it from moving, if stationary), was discussed in detail in *Engineering and Mining Journal* of April 20, 1929, pages 647-48. At that time the chain feeder of the Ross Screen & Feeder Company, 247 Park Ave., New York, to which reference was made, was just being introduced in North America, although in use abroad for two years previously. A point stressed by the company was that it was as applicable in mine chutes underground as it was in bins on the surface at mills and other plants.

At or about this time, the Horne Copper Corporation, at Noranda, Quebec, was completing its plans for an underground crusher station. The crusher, a 36x48-in. Buchanan jaw-type breaker, was to receive its feed from an ore pocket cut in the rock and having 4,000 tons' storage capacity. The ore to be handled was a very heavy sulphide, which broke large, the pieces of maximum size being 36-in. cubes and the average 12-in. cubes. Crusher feed desired was 300 tons per hour.

The engineers had planned to control the flow of ore from the pocket to the crusher through an opening 54 in. wide and 44 in. high by means of a finger gate, but, hearing of the chain feeder, made inquiries about it, at the same time expressing doubt that it would be able to handle such large pieces of ore successfully. They were assured that a No. 8C feeder, working in a chute 48 in. wide at the end (delivering at right angles to the 48-in. side of the crusher opening) and requiring approximately 4 hp. to operate, was capable of controlling the flow of material specified and that under no conditions would the ore be able to pass the chain curtain. So sure was the manufacturer on this point that he stated that, even if the pocket were emptied and carloads of the biggest material were dumped into it, the ore would not get by the chains. Further, he suggested that the height of the chute opening (44 in.) be increased to make the throat 54 in. high in a line at right angles to the chute bottom, to avoid all possibility of choking.

As a result, a No. 8C chain feeder was installed by the Horne company. In the size and weight of the chains composing the curtain and the total weight of the latter is found an explanation of the confidence of the manufacturer that the installation would prove successful. The curtain consists of seven chains of 36 60-lb. (approximately), 2¾-in. links each, the total weight being 14,875 lb. To feed 300 tons an hour these chains move at a speed of 22 ft. a minute, or approximately three revolutions of the drum from which they hang.

As supplied by the manufacturer, the equipment included the structural-steel supporting frame and driving gear

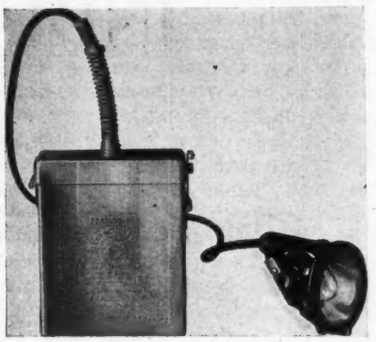

4,000-ton storage
The feeder will take care of a throat here up to 4'-6" (about 5'-6" on the vertical)
Chain speed 22 ft. per min.
4 R.p.m. approx. 300 tons per hr. 4 hp. required
36"x48" crusher
25'-4"
No. 3c. feeder
36" belt conveyor

Sketch showing approximate arrangement of chain feeder (No. 8C) at underground crusher station, Horne mine. Actually the drive is at the right of the feeder instead of the left as shown in the end view.

Chain feeder in Horne mine, Noranda, Que., controlling flow of ore from pocket to crusher. Each link weighs 60 lb. Chain curtain weighs over 7 tons and moves at 22 ft. per minute to feed 300 tons per hour. It is driven by 5-hp. motor, seen in upper right.

complete, back to the motor. The latter is a 5-hp. English Electric Company motor (55 volt, 25 cycle, 3 phase). It is coupled with a speed reducer. The accompanying sketch shows the layout, without details. The feeder and the crusher it supplies are seen in the halftone.

Evidence that the feeder has successfully performed the service for which it was installed is found in the fact that the Horne company has recently duplicated the order. The new feeder will supply the same crusher from a second raise some distance away and in a direction at 90 deg. to that of the first ore stream. It will differ from the first only in having one chain less, this because it will feed at right angles to the 36-in. side of the crusher opening.



Bakelite is used in the headpiece of this electric cap lamp

Some Improvements in Underground Lighting—Other New Devices

THANKS to the attention given by operators to the problem of improving electric current supply, the power supplied to mine haulage systems today is largely free from extreme fluctuation. To secure locomotive headlights of the desired brilliance for underground haulage work in the past, operators have employed the arc light,

This incandescent-type motor headlight replaces the customary arc-type

this being the only illuminant not greatly influenced by unsteady voltage. The arc light, however, has not been entirely satisfactory, because of the constant attention necessary for its upkeep. In view of the improved power supply, the use of incandescent lamps in place of arc lamps is rendered practicable and a special (Type MS) incandescent mine headlight has been introduced by the Ohio Brass Company. Where the voltage is fairly uniform, states the company, this light is the equal of arc headlights and at the same time costs less to maintain.

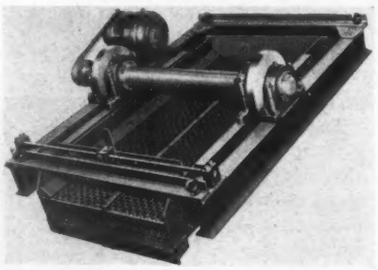
A Centrifugal Vibrating Screen

In view of the importance of vibrating screens for sizing, Allis-Chalmers has developed a screen of this type, which it has styled "Centrifugal." The vibrating motion is produced mechanically and transmitted to the screen body so that it is equal over the entire screen surface, thus insuring maximum capacity under all conditions.

The screen is made in various sizes and with single or multiple decks. It is sturdily built and has self-aligning, anti-friction roller bearings. The screen surfaces are easily removed. The angle at which they are set may be easily adjusted. Enclosed fan-cooled, squirrel-cage motors with anti-friction bearings are used for driving these screens through short-center V-belt drives.

Measures Air Velocity

For making rapid and accurate surveys of air and gas currents, the O. Zernickow Company, 15 Park Row, New York, has devised an instrument which combines the so-called "Robinson" cup cross with a centrifugal tachometer. This has been given the name of the O-Z anemo-tachometer. Ordinarily, anemometers are used to give the total distance in miles over a certain period—for instance, one minute. From this the average speed for the total duration of the test is ascertained by using a calibrating table. These instruments, however, do not serve the purpose when the exact speed at any moment and the time and amount of speed fluctuations are desired. The new device shows instantaneously the air velocity and its fluctuations in miles per hour and meters per second. It may be used for determining air capacities of fans, pumps, compressors, and blowers, in addition to measuring the speed of air and gas current in general.



A new vibrating screen

Electric Cap Lamp Improved

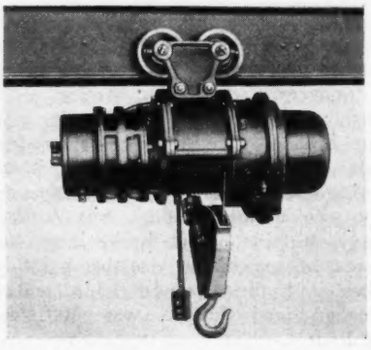
An accompanying photograph shows the new Edison Model H miner's electric safety cap lamp. The headpiece is of bakelite and is designed to direct the light where it can be most efficiently used, whether the user is working or walking. The maximum beam candle power falls in the direct line of vision, this arrangement also throwing more light to the feet, which is of advantage in walking. The reflector has 33 per cent greater reflectivity than previous models and a much increased beam candle power, and is more strongly and compactly built. A gooseneck replaces the cap-hook eyelet, an advantage in low places. A single two-filament gas-filled bulb is employed, permitting use of the entire surface of the reflector, and increasing the total amount of light available. Mine Safety Appliances Co., Pittsburgh, is the maker.

For High-Speed Hoisting

To speed up the handling of materials about a plant, a new line of electric hoists, ranging in capacity from one-half ton to 10 tons and designed to permit high-speed operation, has been developed by the Milwaukee Electric Crane and Hoist division of the Harnischfeger Corporation. The new hoist has roller bearings, forged, heat-treated gears and pinions, forged steel wheels, and alloy-steel shafts which are ground to size. It is shown below.

Standardizing Driving Mediums

Standardized drives for screw conveyors have been developed by H. W. Caldwell & Son Company, Chicago (subsidiary of the Link-Belt Company), in pursuance of their plan to standardize various driving mediums. This drive is for conveyors 8 to 16 in. in diameter and is produced in two types, C and D. The first involves two speed reductions between motor and conveyor, each through a silent chain drive fully in-

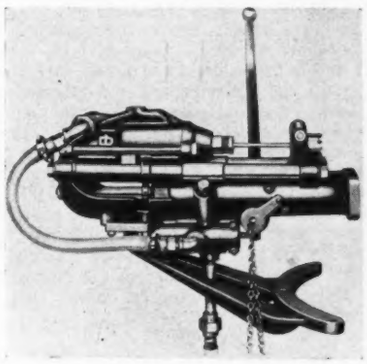


For plant hoisting

closed in an oil-retaining steel casing, and an efficient worm gear speed reducer designed to serve as a thrust end and a drive for the conveyor. The second drive (Type D) consists of a direct-coupled reducer mounted with motor on a unit base plate. This permits the selection of a worm-gear reducer according to the horsepower rating, without regard to the size of the conveyor trough. All of the reducer bearings are anti-friction with automatic lubrication. These standard drives permit a range of conveyor speeds from 45 to 125 r.p.m., standard motors of 860, 1,160, 710, or 1,430 r.p.m. being used.

For the Steel Sharpener

A new line of shank-and-bit punches designed to fit its No. 34 drill-steel sharpener has been introduced by Ingersoll-Rand. One of these punches is shown in the accompanying cut. Feed cylinder, valve chest oiler, and guide holder are constructed in one piece. The valve chest is bushed. Operation is said



Representing a new line of shank-and-bit punches for steel sharpening

to be speeded by the short throw and easy reach of the operating lever. Complete lubrication is maintained from one oil chamber.

In action, the punch is positive, the punching pin being driven out of, as well as into, the steel, which is held clamped in the sharpener meanwhile. Combination shank-and-bit guides permit handling both bits and shanks on any one steel section without changing guides, and assure correct alignment of the steel to be punched. Equipped with this punch, the No. 34 sharpener will handle any section of drill steel up to 1⅛ in. in diameter and will make bits up to 2½ in. in diameter.

For Welders

A new rod (Weldite C-No. 6 fluxed) has been introduced for carbon-arc welding by the Fusion Welding Corporation, of Chicago. It is said to be adaptable for welding mild plates and castings at substantially increased speed. It gives a strong and ductile deposit, which is more readily machinable than deposits made with the filler rod that is usually employed with the carbon-arc process.

A New Frequency Meter

The design of a new frequency meter (Type SY), introduced by Westinghouse, is such as to permit the production of instruments having a scale range of plus or minus two cycles for 60-cycle work, with operating torques at least equal to those used in corresponding voltmeters, and a remarkable freedom from temperature or voltage error effects. The circuit design is such that the indication depends only on the values of inductive and capacitative reactance. Thus the temperature effect is so small that it can hardly be measured. The use of a special type of condenser is partly responsible for this. The ranges obtainable are from 54 to 66 cycles, or from 58 to 62 cycles for use on 60-cycle systems. Inasmuch as the instrument is responsive to changes of 0.01 cycles, frequency changes caused by variations in the load can be readily observed.

Belt Lacing Improved

Complaints having been received that the rawhide pins supplied for certain sizes of its steel belt lacing were not entirely satisfactory under damp or wet conditions, the Flexible Steel Lacing Company of Chicago, is now furnishing sectional steel rocker-hinge pins for its No. 15 Alligator lacing and a new type of corrugated wire hinge pins for its Nos. 00 and 1 lacing.

A Seven-Mile Rope

What is said to be the longest, single-piece of wire rope fabricated on the preformed principle has recently been made in England by British Ropes, Ltd. This rope is 1⅛ in. in diameter, 6x7 Lang lay, 37,500 ft. long, and weighs 35 tons. It is now in use as a mine haulage rope and is working in a coal mine which extends under the sea.

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Machining Manganese Steel

IN AN ARTICLE on the use of manganese steel in mining, in the issue of Jan. 9, 1930, the statement was made that "the tough character of manganese steel precludes the use of machine tools." Commenting on this in a recent letter, Edgar Allen & Co., Sheffield, England, says:

"If this statement is intended as a limited and conditional one, it is, of course, correct, as there are certain operations on manganese steel that cannot be carried out with machine tools, grinding in such instances being the only possible operation. Probably this was what the author meant.

"The statement as it stands, however, is too sweeping, and is likely to convey a wrong impression to the reader not fully abreast of recent tool steel developments. In a great many operations on manganese steel the use of machine tools provided with the very latest high-speed steels is a perfectly sound commercial proposition. For example, in our own works, on commercial production, one of our special design twist drills has drilled as many as 88 holes of $\frac{33}{64}$-in. diameter through cast manganese steel $\frac{7}{8}$ to $\frac{1}{2}$ in. in thickness, without a grind. In regard to machining as distinct from drilling, in a large English works, manganese steel castings have been successfully machined with high-speed steel at 11 ft. per minute with $\frac{1}{16}$-in. cut and $\frac{1}{3}$-in. feed. The cuttings were not torn off, but were genuinely cut.

"We quote these merely as typical examples of what is being done in the way of commercial machining and drilling manganese steel. Modern metallurgical research has effected a revolution in the finishing of exceptionally hard and tough materials, even manganese steel having had to bend the knee, if not to fall."

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A Correction

On page 150 of the Annual Review Number of *Engineering and Mining Journal* an error was made in stating the range of sizes of the Sullivan Machinery Company's angle-compound compressors. In single units these machines are now available in capacities of 287 to 2,553 cu.ft. of free air per minute. In the twin or double units with motor between, the capacities run up to around 5,100 cu.ft.

BULLETINS

Screens — Stephens-Adamson Manufacturing Company, Aurora, Ill. Vibrating screen.

Line Material—Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. Catalog 234. Line material for railways and mines.

Furnace Fans—Wagner Electric Corporation, 6400 Plymouth Ave., St. Louis, Mo. Bulletin No. 166, describing the use of fans for warm air furnaces.

Motors—General Electric Company, Schenectady, N. Y. Bulletin No. GEA-1,171, describing synchronous motors in the mining industry

Zinc Powder—New Jersey Zinc Company, New York, N. Y. "Metallic Zinc Powder in Industrial Paint," comprising historical outline, scope and application of zinc as a paint pigment, and results of tests.

INDUSTRIAL NOTES

P. H. & F. M. Roots Company, of Connersville, Ind., has merged with the Connersville Blower Company and other interests, and is now under the control of the Stacey Engineering Company, of Columbus, Ohio.

Northwest Lead Company, of Seattle, Wash., announces that the employees of its Seattle plant have just completed a 100 per cent safety record, with no lost time accidents during the entire year of 1929.

NEWS OF THE INDUSTRY

Pittman's Silver Tariff Is Passed on Second Vote

ON WEDNESDAY, March 19, Senator Pittman's silver tariff amendment was passed on reconsideration by the U. S. Senate in night session. From the vote of 32 to 36 that previously defeated the amendment a heavy shift in sentiment, brought about a roll call of 55 in favor and only 12 against, with 29 Senators not voting. Senator La Follette, outstanding low-tariff proponent of the progressive group, had the older ballot inserted in the record to show where the changes had occurred. Vote trading is being charged as the cause of reversals on such items as cement, sugar, and other important commodities. Some of the Senators defended their shift in vote by stating that they had not previously thought of silver as a commodity subject to tariff protection like any other product meeting foreign competition. They were impressed by the number of mines that had closed since the last vote.

The Pittman amendment takes silver from the free list and assesses all ores, mattes, bullion, dross, or scrap at 30c. per ounce on the silver content thereof. Provision is made that imports shall be bonded at the duty on twice the estimated silver content and the duties based on later sampling at the refineries under government supervision. Silver may be imported under bond for re-export duty free. Circulating minted coins at an exchange value not over $100 also would be given free entry under the proposal.

A silver tariff will stabilize the hard-hit market by the elimination of dumping from British India and China, Senator Pittman stated in explaining his amendment.

An export association is seen as the next logical step in silver marketing. Such a group could be formed under the Webb-Pomerene Act to carry on the export trade of the entire industry. Senator Pittman stated that since one-fourth of domestic production is for foreign trade, such an organization could work, as in the case of copper, taking 25,000,000 oz. for bank deposit. On this, loans could be made pro rata to the miners pending shipment of the silver at times when the demand is greatest and market conditions are most favorable. Under the present haphazard methods, the Senator declared, the price of the metal is controlled by daily fluctuations in the London market.

Some skepticism is registered among Washington observers as to whether a tariff can be effective on an item with such a large ratio of exportable surplus. According to economic theory, such commodities tend toward the world price regardless of artificial stimulus through a tariff. As silver is produced largely in conjunction with base metals, critics of a tariff argue that the volume of supply is not likely to fall to such an extent that the surplus would not minimize tariff benefit. The burden of government inspection on the smelters and their possible loss of business are named as other objections to a silver duty.

Testimony Taken by House Committee on Government Production of Radium

AFTER having taken the testimony of officials of the U. S. Bureau of Mines and physicians on the Kelly Radium Bill, the House Mines and Mining Committee has decided to consider the matter in executive session for the purpose of determining its action in making a report to the House. The bill, as introduced by Representative Kelly of Pennsylvania, authorizes the Bureau to manufacture 1 gr. of radium and to deliver it to the Veterans' Bureau for use in the government hospitals.

One point that will be considered in the executive session is whether an amendment should be made authorizing the manufacture of a larger amount of radium than was at first contemplated. Representative Kelly has expressed the opinion that production of as much as 5 gr. may be desirable. The appropriation carried in the present bill will have to be increased if the amount of radium called for is increased. The appropriation asked to obtain 1 gr. of radium is $100,000.

Although Bureau officials are somewhat skeptical of the practicability of launching the government into the production of radium, doctors who appeared before the committee were enthusiastic in their indorsement of the plan. Dr. O. P. Hood, chief engineer of the technological branch of the Bureau of Mines, explained that research activities with radium were discontinued after 1915 and that reorganization would be necessary to go into the work again. Only a small amount of the equipment used formerly is in condition for further use, the committee was informed by A. C. Fieldner, chief of the experimental station division. Possibly some radium may be recovered as a byproduct in the manufacture of vanadium, he stated. If suitable arrangements could be worked out with the producers of vanadium, he said, radium could be extracted at a cost of about $50,000 a gram. Mr. Fieldner said that the cost of manufacture has increased 50 per cent since 1915, while the quality of the ores has been deteriorating. He conceded that production of radium might be facilitated by extraction of vanadium. With such extraction the cost of the radium would probably be decreased below $50,000 a gram and other valuable byproducts might further reduce the cost of production, he said.

Dr. Hood interposed the statement at this point that it would be a misfortune for the Bureau to raise expectations for the cheap production of radium that could not be carried out. The entire production of the Bureau up until the time that it discontinued the work amounted to 8 gr. at a total cost of $400,000, he stated. Members of the committee expressed the opinion, however, that modern metallurgical developments should make possible a reduction in the cost of production.

Interest in radium is slight, Paul M. Tyler, acting chief engineer of the Rare Metal and Non-Metals Division, stated. No carnotite has been mined in the United States during the last six years. An extensive domestic radium industry would have to depend on carnotite ores, containing three elements, he declared. Vanadium is the only one of the three for which a wide demand now exists. The Belgian interests are encountering difficulty in moving radium and they have not been able to market any great amount of the uranium residue, he said. A slight demand exists for uranium oxide in coloring glass, but he estimates that twenty tons of uranium is already available to meet any possible domestic needs.

Reserves of radium in domestic ore are about 200 gr., Mr. Tyler said, but figures are not available to show their grade. It is contained in ores averaging 1 or 4 per cent uranium oxide. Carnotite orebodies are small and scattered and the only record available on grade consists of information compiled by the Standard Chemical Company and turned over by that concern to the Belgian producers. Cost of production for Standard Chemical was about $70,000 a gram, and reliable reports indicate that the Belgian interests can produce radium for $20,000 a gram. The high price charged—$70,000 a gram—results from the high selling costs. Many engineers believe that a reduction in the price would not accelerate demand, Mr. Tyler added.

A careful survey of resources would be necessary before the government entered the radium-production field, J. W. Davis, chief engineer of the Information Division, declared. In mining carnotite ore for the National Radium Institute in 1913 about 40 per cent of the personnel had to engage in prospecting, he added. Dr. Howard A. Kelly, of Baltimore, and Dr. T. Abbe, of Washington, testified that the medical profession and the hospitals need large quantities of radium.

■

Verde Central Drifting on Contact at 1,400 Level

Drifting on a quartz-porphyry-greenstone contact on the 1,400 level of the Verde Central mine, near Jerome, Ariz., is being undertaken to prospect this contact and also explore under the favorable showings on the 1,000 level in the Crown Point, Butte, and Apex claims of the company. About 200 ft. of slight quartz and chalcopyrite mineralization has been opened up. Development work at the property has been limited by hoisting capacity, which is required for ore production. As soon as some stopes are emptied of all ore, however, they will be used for dumping waste. No new ore was cut in 1929, but several stopes have shown greater width and length than anticipated. Operation of the new 300-ton concentrator has been satisfactory. A 3-ft. Symons cone crusher and additional MacIntosh flotation cells have been installed.

C. & A. Developing New Ore at Bisbee and Ajo Mines

DEVELOPMENT of new ore reserves at its Bisbee and Ajo mines is indicated in the annual report of Calumet & Arizona Mining, operating copper properties in Arizona and New Mexico. At Bisbee, ore is being developed in the Cole shaft territory that gives promise of new ore zones in hitherto unprospected ground, and at Ajo, work on the approach to the New Cornelia pit has enlarged reserves of both carbonate and sulphide ores. Progress on the construction program has been good, work on the New Cornelia mill and the Bisbee mines being almost complete.

Development at the Cole mine has shown ore in widely separated areas, particularly on the 500 level in the southern part of the Smogler claim and on the 1,200 level in the southwestern part of the Atlas claim, where bodies of high-grade copper-silver ore were recently encountered. Work on the Campbell orebody has shown that it continues from the 1,300 level to below the 2,200 level. An irregular oxide orebody of considerable size has been developed 150 ft. north of the Campbell shaft and a small body of sulphide ore has recently been found on the 1,800 level of the Junction mine in the Reindeer claim. This discovery is in a new area and may prove of great importance, according to D. M. Rait, superintendent of the Bisbee mines.

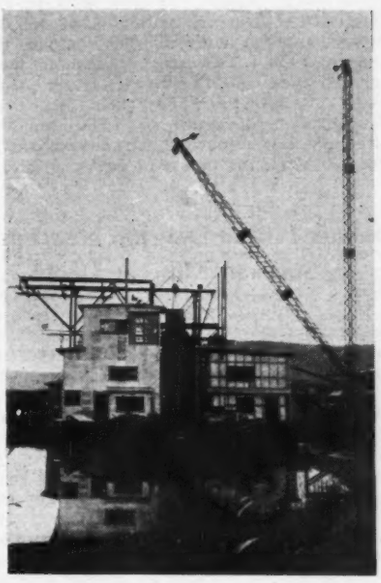
In the development of the new approach at Ajo, additional tonnages of carbonate and sulphide ores were encountered, according to M. Curley, manager of the New Cornelia property. Completion of the approach has been retarded by reason of mining these additional tonnages, as it has been extended beyond the slope lines originally planned. Six diamond-drill holes were completed during 1929, and these have developed a substantial tonnage of sulphide ore. Work on the three new concentrator units, which will bring sulphide-ore capacity up to 15,000 tons daily, is about 85 per cent complete. Installation of a new 7,500-kw. turbine at the power plant has been completed.

At the Eighty-Five mine, near Valedon, N. M., the large flow of water encountered in April, 1929, hampered development work and little new ore has been added to reserves. However, the Jim Crow shaft has now been deepened to 1,117 ft. and connections have been made with the old workings on several levels. Because of the hot water encountered on the 1,650, a Green Fuel Economizer radial flow fan was installed in December to permit continuation of mining at depth.

■

Christmas Sinks New Shaft

A new hoisting shaft is being sunk east of the fault at the Christmas Copper property, near Hayden, Ariz., to supplant the present operating shaft, which is too small to handle the tonnage required for the company's 400-ton concentrator, according to F. P. Knight, president of Iron Cap Copper, which controls the Christmas mine. At present ore to supply the mill is being taken out through a tunnel at the 400 level, from which practically the entire tonnage is being extracted. Development has showed excellent ore at the 800 level after unwatering the shaft, and the new shaft, which will cost about $125,000 to sink and equip, will permit mining this area. In addition to 400 tons of milling ore, the company is shipping about 150 tons of smelting ore daily.



Erecting dredge No. 6 of Fairbanks Exploration, near Fairbanks, Alaska

Idaho Copper Appeal Denied

Due to the lack of a substantial argument, the U. S. Supreme Court on March 12 dismissed the appeal of the Idaho Copper Corporation from an indictment for using the mails to defraud in connection with stock promotion. This verdict was handed down by the district court for southern New York. It mentioned George Graham Rice and the Wall Street *Iconoclast* as co-defendants. The indictment handed down by the district court charges that the defendants "devised and intended to devise a scheme and artifice to defraud" certain persons specified, by inducing them to purchase shares of stock of the Idaho Copper Corporation through false representations as to its value.

■

Finish Seven Troughs Mill

Completion of the new 100-ton cyanide mill of Seven Troughs Gold, near Lovelock, Nev., and starting of operations at the plant is expected by April 15. Development work at the mine was curtailed early in the month, pending the completion of the new 11,000-ft. air line on March 15. Three raises have been put up from the south drift on the 7,800 crosscut, however, and all are reported to be in ore. Connection between the new tunnel workings and the bottom of the old Tyler shaft has been made by a 600-ft. winze.

■

Water Hampers Gold Hill

Work on the 300 and 400 levels of the Gold Hill Development property, near Round Mountain, Nev., has been suspended because of the heavy flow of water struck on the 400 level. Seventeen men have been laid off, pending the arrival of heavy-duty pumps ordered. Work is being continued on the 115 and 225 levels, however. A total of 1,000 ft. of ore has now been opened on the 225 level. Preparations for installation of the pumps is now being made.

2,000-Ton Mill Planned at Errington Mine

OPERATIONS of Treadwell Yukon at the Errington mine, in the Sudbury district of Ontario, will be on a basis of 2,000 tons of zinc-copper-lead ore daily, if the present development program fulfills expectations, according to F. W. Bradley, president of the company. In addition to a concentrator to handle this tonnage, a smelter and an electrolytic zinc plant, with a capacity of 75 tons of zinc daily, will probably be built. The company has notified the Ontario government that 23,000 hp. will probably be needed in 1931.

At present, the Errington mine is producing 275 tons of ore daily for its pilot selective flotation plant from orebodies above the 500 level. Developments to that depth alone have indicated sufficient ore for a larger plant, but the exploratory work that will be undertaken on the 1,500 level this summer will determine whether the 2,000-ton mill is to be built. Drilling has indicated that ore continues to that depth. No. 2 shaft is expected to reach the 1,500 level about the middle of July. It is now down to 900 ft. If the 1,500 level duplicates the results obtained on the 500 level, sufficient ore for fifteen years of operation of a 2,000-ton plant will have been put in sight. The operation of the pilot plant indicates an average extraction of more than 70 per cent of the metal content of the ore.

Ore reserves at the adjoining Sudbury Basin property have been estimated at 833,000 tons between the 250 and 500 levels. Ore above 250 ft. is not estimated, as it will probably have to be left in place for protection. As estimated, the ore occurs in two sections and averages about 2.8 per cent copper, 1.5 per cent lead, 5.8 per cent zinc, 2 oz. of silver, and 0.03 oz. of gold to the ton. Although drilling has been continued below 500 ft., the work has been insufficient to justify estimating reserves below that depth. No plan for metallurgical treatment of the ore has yet been advanced, and production will probably not be started until Treadwell Yukon makes a final decision.

■

Abana to Build 300-Ton Mill

Abana Mines will proceed with construction of a concentrator, with capacity of from 250 to 300 tons daily, at its mine near Dupuy, Que. Only copper ore, carrying some zinc, will be treated at first, as the management has decided to wait until an electrolytic zinc plane is built in eastern Canada before extracting the zinc ore, according to H. E. Clement, general manager of the mine. Reserves are estimated at 190,100 tons of copper ore, averaging 5 per cent copper and 8 per cent zinc, and 275,400 tons of zinc ore, averaging 17 per cent zinc and 1 per cent copper, on Feb. 1, 1930. Of this total, about 240,000 tons has been put in sight within the last year. Reserves are all above 600 ft., whereas drilling has indicated that ore continues to 1,250 ft.

The ratio of concentration for copper ore will be about five to one for the copper concentrate, which is expected to have a grade of 23 per cent copper, and seven to one for the zinc concentrate, which will have a grade of 50 per cent zinc. Zinc concentrate will be stockpiled until a local market is obtained.

Low Lead Price Closes Mines and Cuts Wages in West

Decline in the price of lead to 5.50c. a pound in the New York market has caused the suspension of operations at several mines in the West and has forced a reduction of 50c. a day in miners' wages in the Utah and Coeur d'Alene lead-mining districts. News from abroad indicates that some cut in the rate of production will be decided on by European producers, but no definite agreement has been reached.

The reduction in wages in Utah affects only lead operations, as the Utah Copper mine and the Garfield copper smelter of American Smelting & Refining are maintaining wages. At lead smelters the cut is only 25c. a day, but in the mines of the Park City, Tintic, and Bingham districts, already affected by low zinc and silver prices, the reduction is 50c. These reductions were made effective March 10. In the Coeur d'Alene district the cut was made effective March 15 and applies as 50c. daily to all mine, mill, and smelter employees.

Among the mines that have closed are the Dresser and Altamont properties, in the Silverton district of Colorado, and the Tamarack & Custer mine, in the Coeur d'Alene district. Both the Altamont and the Dresser mills have a capacity of 100 tons daily. Shipments from the Altamont have been about five carloads of concentrate a month, and, as a fairly large reserve of broken ore is available in the mine, milling will be continued until this reserve is exhausted. Development work at the Garry Owen mine of Dresser Mining will probably be continued.

At the Tamarack mine, about 70 men have been dismissed. This is more than half the usual force. The remainder will be used in development work west of the fault on the 1,200 level and in sinking a winze from the same level. Shipments to the Hercules mill from this property had been about 150 tons daily. Reports that the Sherman Lead property, controlled by Tamarack, would be closed have not been confirmed.

■

Federal Opening Up 3,650 Level of Morning Mine in Idaho

Deepening of the main shaft at the Morning mine of Federal Mining & Smelting, in the Coeur d'Alene district, Idaho, has been undertaken to permit development of the 3,650 level. At present, ore has been opened up to the 3,450 level, which is 4,900 ft. below the surface and makes the Morning mine probably the deepest lead mine in the world. The new level will be about a mile below the surface. Hoisting equipment at the Morning mine, installed in 1928, will permit of operation to a depth of 6,000 ft. from the surface.

During 1929, although 380,660 tons was mined from the property and no new levels were developed, ore reserves at the end of the year were estimated at 1,653,200 tons, according to Frederick Burbidge, general manager of the company. This is only 214,400 tons less than at the end of 1928 and indicates that the areas mined yielded 166,260 tons more than had been estimated. As the orebody has been improving in width and grade for the last 600 ft. of depth, the management expects that a considerable tonnage will be added by development of the new level.

Development work at the Page-Blackhawk mine, the only other property that the company is now operating in Idaho, was encouraging and ore reserves at the end of the year are estimated at 538,200 tons, compared with 270,000 tons at the end of 1928. Two more oreshoots have been opened in Blackhawk ground. In Page ground, the Tony vein has been developed to a depth of 1,200 ft., and although it is somewhat narrower than on the 900 level, the ore is of better grade.

■

Bunker Hill to Develop New Find in Sullivan Mine at Depth

In the Sullivan mine of Bunker Hill & Sullivan, Coeur d'Alene district, Idaho, reserves have been considerably increased by the discovery of a new high-grade silver-lead orebody on the No. 6 level. The limits of this new ore have not yet been reached laterally, and a crosscut on the flood level, 150 ft. below the No. 6 level, has shown that it continues to that depth. Exploration will be undertaken on the Nos. 9 and 17 levels.

Shaft sinking has been resumed in the Bunker Hill mine to develop the orebodies found at the No. 19 level at greater depths. At present the No. 19 level, 2,000 ft. below the Kellogg tunnel, is the deepest working in the mine. The orebody cut in the Kramer crosscut, west of the shaft, is not believed to be the main oreshoot mined on upper levels, according to Stanly A. Easton, general manager of the company. Search for the main oreshoot is being continued on the Nos. 18 and 19 levels, below its last known exposure in the Beaver intermediate level, 131 ft. above the No. 18.

■

Kennedy Reaches 4,800 Level; Argonaut Shaft Cuts Ore

Kennedy Mining & Milling has completed the first part of the auxiliary incline shaft starting from the 4,650 level of its property at Jackson, Calif. A total of 275 ft. has been sunk at an angle of 65 deg. Preparations are now being made to cut a chamber for the water tank. In the near future, the 4,800 level station will be established and development work at that depth started.

In the adjoining Argonaut mine, shaft sinking recently cut a rich stringer of gold ore a short distance below the 5,600 level. The company is now sinking the shaft deeper.

■

Homestake Maintains Reserves

Despite production of more than $30,000,000 in five years since 1924, ore reserves at the Homestake Mining gold property at Lead, S. D., have shown practically no change. Gold has been produced since 1879 at this property, and the total output is about $226,000,000. Although supposed to be nearing its end several years ago, reserves on Dec. 31, 1929, were estimated at 686,495 tons of broken ore and 15,176,740 tons of blocked-out ore, or about ten years of life at the current rate of production. In 1924 reserves were estimated at 686,918 tons of broken ore and 15,815,118 tons of blocked-out ore. An increased amount of development work was done in 1929, 14,964 ft. of drifting and 8,768 ft. of raising, compared with 11,486 ft. of drifting and 7,064 ft. of raising in 1928. About 150 miles of workings have been driven in all. Development on the 2,600 level of the mine has been encouraging, according to B. C. Yates, general manager.

Cleary Hills Finds Extension of Rhoads-Hall Orebody

Cleary Hills Gold Mines, operating the Rhoads-Hall mine, on Bedrock Creek, Fairbanks, Alaska, has discovered the continuation of the original orebody at its property. Before the World War the Rhoads-Hall property produced about $600,000 in gold, but the vein was lost, through faulting, and efforts to discover its continuation were unavailing. Surface work done last summer revealed a high-grade shoot. Since then, underground development has shown that it is the continuation of the original orebody. On the No. 1 level, high-grade ore has now been developed for a length of 200 ft. over an average width of 1 ft. E. N. Patty, of the Alaska College of Mines, is consulting engineer for Cleary Hills.

■

A. S. & R. Options Frisco Lulu, in Beaver County, Utah

American Smelting & Refining has signed a working agreement to undertake exploration work on the Frisco Lulu Mining property, at Frisco, Beaver County, Utah, adjoining the Horn Silver mine. New equipment will be installed at the property and the old shaft, 700 ft. deep, will be used as a base of operations. Work will be started at once, according to A. H. Means, manager of mines for the Western division of A. S. & R. The ore is silver-lead-zinc.

This project further extends the Utah exploration activities of the smelting company, which now include a large acreage in the Park City district and most of the mines in the American Fork district as well. At Park City, diamond drilling will be started this spring on the Silver Creek group, northwest of the Silver King Coalition property, to check results of a geophysical survey.

■

Engels Adds Flotation Unit to Calaveras Concentrator

Installation of 14-cell Kraut flotation machines at the Calaveras concentrator, near Copperopolis, Calif., has been completed by Engels Copper. The equipment will handle 400 tons of 3 per cent copper ore daily, which is the tonnage the company intends to produce from the mine, reopened last spring.

Sinking of the Keystone shaft has now proceeded to a point below 600 ft., and the Discovery shaft has been deepened to 1,624 ft. Ore has been cut on the so-called 1,650 level of the Discovery shaft, but drifting has not yet started at the 1,800 level. Drifting toward the ore has been started from the 525 level of the Keystone shaft, which is being equipped to permit sinking to 2,000 ft. Reserves are estimated at 329,940 tons of ore on Dec. 31, 1929, in the annual report of Engels Copper.

At the Engels mine, in Plumas County, the company has done a great deal of exploration work, including 8,490 ft. of diamond drilling and 8,180 ft. of drifting and raising. In diamond drilling, an orebody 12 to 15 ft. wide, and assaying about 4.5 per cent copper, was cut 250 ft. below the No. 15 level. With this exception exploration results have been disappointing and a reduction in the output of the mine, now about 1,100 tons daily, will probably have to be made soon unless more ore is found. Total reserves are only 311,849 tons of ore.

Eureka Standard, First Gold Mine in Tintic, Starts Production on Large Scale

GAIL MARTIN
Salt Lake City, Utah

STARTING of operations on March 6 at the Eureka Standard mine, controlled by Tintic Standard, marked a new phase in the history of the Tintic district of Utah. For the first time in its sixty years of production, the district has a producer carrying gold as the most important metal, not lead or silver. Occurrence of the Eureka Standard ore in Cambrian quartzite is also unusual, for, until this property was developed, no orebody had ever been found in the quartzite formation at Tintic. Production had always come from limestones in the past. Eureka Standard is equipped to handle daily 300 tons of gold ore, said to average nearly 1 oz. in gold per ton, indicating an annual output of about 100,000 oz. of gold.

Operations at Eureka Standard were started seven years ago. Hopes for ore were based only on geological deductions. As at the Tintic Standard property, a "pothole" or depression existed. The underlying Ophir limestones had been downfaulted into a quartzite trough. The surface rhyolite was bleached from purple to gray, indicating intense sericitization, silicification, and chloritization.

A four-compartment shaft was sunk because of the unusually high rock temperatures existing in the East Tintic section and the gas pockets struck in exploration work. Hoisting compartments of the shaft are 4 ft. 1 in. x 4 ft. 8 in.; the ventilation compartment, upcast, is 8x4⅝ ft.; and the manway is 2½x4 ft. One of the hoisting compartments is used for a downcast air current.

In drifting to the Ophir formation, overlying the Cambrian quartzite, gold ore was cut in a series of fissures paralleling the contact. Development of this ore opened up a large body, carrying gold and some silver. Iron pyrite and gray copper were originally supposed to be the gold-bearing minerals, but study has as yet failed to identify them. At present the barite and quartz found in the orebody are being studied in the belief that they may carry the gold.

As development disclosed the size of the orebody, the management decided that the property should be equipped to hoist ore through its own shaft. Up to the present the entire production has been hauled underground for a mile to the Tintic Standard No. 2 shaft at Dividend for hoisting. Work on the new surface plant was started a year ago. A spur line has been built by the Denver & Rio Grande Western Railroad to connect with its Iron King branch line.

An 85-ft. steel headframe, equipped with two 7-ft. cast-steel bicycle-type sheave wheels, has been put up by the Provo Foundry & Machinery Company. The headframe and sheave wheels are designed for four-ton skips and 1¼-in. hoisting rope in the event that a larger hoisting capacity should be desired later. At present a 200-hp. double-drum Wellman-Seaver-Morgan electric hoist is in use. It has a rope pull of 9,500 lb. and a speed of 650 ft. per minute.

Ore is trammed to the 1,100 and 1,300 level stations in Ogden Iron Works mine cars, with 18-cu.ft. capacity, and dumped into 60-ton skip pockets, cut out of the quartzite country rock and having concrete retaining walls. Each skip pocket has a measuring pocket, emptied by an 18x24-in. steel gate, that has the same capacity as the skips and thus insures rapid and accurate loading. Skips are dumped into a 20-ton steel bin, from which a Stephens-Adamson pan conveyor carries the ore to a 30-in. belt conveyor, 75 ft. long, that feeds the 150-ton steel ore bin at the railroad. Both the pan and the belt conveyors are driven by individual General Electric motors through Foote gear speed reducers, controlled by electric switches and push buttons, which have been installed at the hoist engineer's station. Thus one man can control both hoisting and delivery of the ore to the bin. The belt conveyor, inclosed in a fireproof steel building, was also built by the Provo Foundry & Machinery Company. Single-deck cages are used for handling men, supplies, and waste. Handling waste will be discontinued as soon as some stopes have been mined.

The change from cages to skips will be made on the surface by transfer cars specially constructed by the Ogden Iron Works. A section of the hoisting guides on the headframe is hinged so as to swing back out of the hoisting compartment. The transfer car is then placed under the cage or skip, a hinged section of track being put across the shaft. As the transfer car is moved away from the shaft, the cage or skip is lowered to a horizontal position on the car. When the hoisting cable has been removed, the car is placed on a side track, near the shaft. The operation, of course, is reversed with the other car which carries the equipment to be used. This transfer can be made in a very short time.

For mining operations, a 2,700-cu.ft. Ingersoll-Rand compressor is used. It supplies compressed air through an 8-in. line in the shaft, with 3-in. connections to the various levels. A 70,000-cu. ft. Bayley fan draws air from the mine. Fresh air is distributed throughout the mine in 16-in. lines, with Coppus booster fans used at intervals. A fireproof tunnel, 6x8 ft., and 75 ft. long, leads from the ventilation compartment of the shaft to the fan, thus keeping the collar of the shaft free from water and ice during the winter and giving added safety from fire. A change house, capable of accommodating 120 men, has been built. The blacksmith shop is equipped with an Ingersoll-Rand drill sharpener.

Surface plant at Eureka Standard

■

Annie Laurie Con. Starts Work on Properties at Sevier, Utah

Development has started on the Annie Laurie Consolidated Gold properties, consisting of 2,600 acres in Piute and Sevier counties, Utah, from which about $2,800,000 in gold was produced during 1901-1908. At present work is being centered on a quartz vein between the Nos. 4 and 5 tunnel levels, 500 ft. apart, vertically. A power line is being built to the mine from Fish Creek, 2 miles distant. Until this power is available, a gasoline engine is being used. B. F. Bauer is president of the company and F. L. Tilton is in charge of operations.

Production from the Annie Laurie mine in the past was obtained entirely from igneous rocks. In view of recent discoveries in the quartzite and limestone formations of the Tintic district, present operations will be centered on following the known orebodies in the rhyolite into the buried sedimentaries. Operations were suspended at the property in 1908 because of the death of the owners and litigation.

■

Ariz. Commercial Near End

As development work in the mine has failed to find new ore, production from the Arizona Commercial copper mine, at Globe, Ariz., will probably have to cease within a few months, according to Sumner Smith, president of the company. Only about 25,000 tons of 2.5 per cent ore remains in the mine. A considerable quantity of sulphide material, averaging 1.25 per cent copper, was indicated by drilling below the 2,200 level. Development costs at depth are likely to be greatly increased because of the higher water flow, difficulties in shaft sinking due to faulting, and high rock temperatures. The diabase formation gives way to schist at a depth of 2,350 ft. and the area below that level is believed to be more favorable for ore deposition than the 800 ft. immediately above.

Large Attendance at Meeting of Canadian Institute

About 500 registered at the annual meeting of the Canadian Institute of Mining and Metallurgy in Toronto on March 5, 6 and 7, the largest attendance in the organization's history. All technical sessions were conducted in the new Royal York hotel, as well as the smoker, the dinner-dance, and the annual banquet. One of the features of the meeting was an exhibition of minerals and mining equipment on the convention floor of the hotel.

Among the speakers who addressed the members were Charles McCrea, Minister of Mines for Ontario, who spoke at the luncheon on the first day; Hon. Howard Ferguson, premier of Ontario, and Hon. Charles Stewart, Minister of Mines for the Dominion, who spoke at the annual banquet. W. H. Bassett, president of the A.I.M.E., also spoke at the banquet. Dr. J. S. Delury was inaugurated as president at the banquet, succeeding Norman R. Fisher.

Radium, sponge iron, and Ontario lignite, three mineral products that are at present only of potential importance in Canada, were the subjects of addresses by H. S. Spence, Prof. Bradley Stoughton, and W. S. Dyer, respectively, that aroused considerable discussion at the technical sessions. Statistics of production in the Dominion and the several provinces were presented on the morning of March 5.

■

Large Increase in Reserves of Low-Grade Ore at Noranda

Development work done during 1929 greatly increased the reserves of low-grade ore at the Horne copper mine of Noranda Mines, near Rouyn, Que., according to E. Hibbert, general manager of the company. A susbtantial increase is also shown in reserves of high-grade material. Total reserves on Dec. 31, 1929, were 3,426,000 tons of direct-smelting ore, averaging 7.5 per cent copper and $3.29 a ton in gold; 3,000,000 tons of concentrating ore, averaging 2 per cent copper and $3 a ton in gold; and 238,000 tons of siliceous ore, used as flux, averaging 1 per cent copper and $2.43 a ton in gold. In 1928, all ores were grouped under one heading and were estimated at 3,097,000 tons, averaging 7.3 per cent copper and $3.68 a ton in gold. Concentrator capacity at Noranda is being increased to 1,000 tons daily from the former capacity of about 300 tons indicating that the company is preparing to make use of its reserves of low-grade ore.

■

Dome Reserves Increased; Tests to Determine Mill Policy

Ore reserves at Dome Mines were increased slightly from 1,250,000 tons to 1,300,000 tons during 1929, according to H. P. De Pencier, general manager of the company, despite the extraction of 467,300 tons of ore during the ten months that the mill was in operation. Most of the additions to ore reserves were made in the greenstone area, where ore is of slightly lower grade than it is in the sedimentary basin. The most important addition to reserves was a new orebody, 25 ft. wide, which has been opened up for 235 ft. on the No. 15 level and for 440 ft. on No. 16 level. It averages about $7.50 in grade.

Since the Dome mill burned in October, careful consideration has been given to various proposals for treating Dome ore, Mr. De Pencier states in the company's annual report. Metallurgical tests are now being made that may aid in coming to a decision. Work on clearing away the débris has been started and should be finished as soon as the weather permits. By that time the company expects to be in a position to start construction of a new plant. In the meanwhile, a new Symons cone crusher has been added to the crushing plant, which was not damaged in the fire. In the financial statement, the value of the mill buildings destroyed in the fire, together with equipment, is put at $828,573.

Cinco Minas Closes Mine and 500-Ton Mill in Jalisco

Mexican federal authorities on March 15 authorized the definite closing of the Cinco Minas property, in Jalisco, after inspectors reported complete exhaustion of the ores. Application of the miners to work the mine on a profit-sharing basis has been refused. The company employed about 800 miners, and all of these men have been allowed two weeks' wages. Cinco Minas had been in operation for twenty years and was one of the best-known properties on the Mexican west coast. Production figures were not published, as it was owned entirely by the Daly interests, but the tonnage handled in the cyanide plant was about 500 tons of silver-gold ore daily.

■ ■ ■

C. & H. Starts Working at Centennial; Progress Made in Adopting Flotation

AT CENTENNIAL No. 2 shaft of Calumet & Hecla Consolidated, in the Michigan copper district, work incidental to resumption of operations has been completed. The hoist, which has a capacity of 6,000 ft., has been overhauled and the surface plant is ready. This shaft has been timbered and equipped down to the 43 level to connect with the drift south from No. 1 North Kearsarge shaft at that depth. North of the Centennial shaft, good ground has been opened. Development will also be undertaken in virgin territory to the south.

Calumet & Hecla is also engaged in important development work at its Osceola amygdaloid branch. A crosscut from No. 12 shaft at the 78 level has cut the bed several thousand feet below the present workings. No development has been done yet, but the crosscut is being extended toward Kearsarge lode. At the north end of the Osceola branch, two long drifts are being driven north from No. 17 shaft in the direction of Centennial ground. Although the Osceola bed was cut in Centennial several years ago, it has not been extensively developed. New ore developed in the Osceola branch during 1929 was of slightly lower grade than that developed in 1928.

In Ahmeek territory, development has also shown lower grade ore, according to the company's annual report. No. 2 Ahmeek shaft, which has been deepened to No. 40 level, has been handling a much larger flow of water recently. Two electric pumps are being installed on the No. 11 level, and two more will be put in at the No. 34 level to provide for any future increases. No. 4 Ahmeek shaft has developed ore of better grade at depth, and it will be deepened to No. 38 level.

At the company's Ahmeek mill, the work of installing Fahrenwald flotation equipment made considerable progress during 1929. Recovery has shown the increase anticipated by tests made two years ago by the U. S. Bureau of Mines. Installation of a 2,000-kw. low-pressure unit at the Lake Linden power plant will permit finer grinding of the tailing at this mill and should result in even better recoveries by flotation. At the No. 2 mill of Lake Milling, flotation equipment has also been installed. This plant is handling ore from Seneca Copper as well as Osceola amygdaloid output from Calumet & Hecla. No. 1 mill is being dismantled.

The Calumet & Hecla smelter has recently been in operation three times a week instead of twice, reflecting an improvement in metal demand, as the smelter is being operated only as orders are received. Concentrate is accumulating in the new storage building, which has a capacity of 15,000 tons. The efficiency of the plant has been greatly increased and smelter losses are now only 0.4 per cent. Operating costs have also been materially decreased.

■

Goldfield Consolidated Drops Option on Berengaria Mine

Reno, Nev., March 19.—George Wingfield, president of Goldfield Consolidated, announces that his company has abandoned its option on the Berengaria silver-lead property, near Kootenay Bay, B. C. Mining Corporation of Canada also had an interest on the option, on the same basis as the participation of the two companies in the Base Metals property, near Field, B. C. Mr. Wingfield stated that returns from the Base Metals production of lead and zinc concentrate in February were $65,000. Mining and milling costs, for 300 to 350 tons of ore daily, are stated to be only $3 a ton. Recovery of the metal content of the ore is said to be exceptionally high, about 95 per cent in concentrating. Detailed information will be made available when the Goldfield report, now in the hands of the certified public accountants, is published. Drifts on the Monarch orebody are still in ore showing about 25 per cent combined lead and zinc, but the width is improving.

■

Bluebell Strikes Orebody on Adjoining Comfort Claim

Bluebell Mines has struck silver-lead ore in the incline shaft it is sinking on the Comfort claim, about 1,500 ft. from the Bluebell workings, near Ainsworth, B. C. This development work is being financed by Consolidated Mining & Smelting. About 500,000 tons of ore has been shipped from the Bluebell property, but little work has been undertaken on the Comfort. If the present campaign is successful, Consolidated will assume control of Bluebell.

Kingman Mining Revival Draws 280 Miners to Mohave County

Registration at the fourth of the series of Arizona mining revivals, held this time at Kingman, center of the industry in Mohave County, reached the impressive total of 283. The meeting was held on March 8 and 9 and was devoted to a study of mining and mining possibilities in Mohave County. The three previous revivals were held in Yuma, Nogales, and Prescott.

Included among the speakers at the revival were S. S. Jones and E. Ross Householder, Mohave County mining engineers; Robert E. S. Heineman, geologist of the University of Arizona; E. P. Mathewson, president of the Arizona section of the A.I.M.E.; E. D. Gardner, supervising engineer of the Southwest Experiment Station of the U. S. Bureau of Mines; and Tom Foster, state mine inspector. Anson Smith, for fifty years a resident of Mohave County, recounted many interesting tales of mining three and four decades ago. W. Val DeCamp, general manager of United Verde Copper, represented the larger corporation and gave the point of view of the larger organization toward aiding the smaller owner of mining properties in the state.

Leroy V. Root, secretary of the Mohave County Chamber of Commerce, and W. B. Gohring, secretary, Arizona chapter of the American Mining Congress, presided at the sessons of the revival.

E. A. Harshberger, chairman of the mines committee of the Tucson Chamber of Commerce, extended an invitation from the Tucson Chamber to hold the next revival in Tucson.

■

Reopen Big Jim at Oatman

Having consummated an arrangement whereby it regained its original claims in the Oatman gold district of Arizona, Big Jim Mines is now retimbering the shaft and building a new headframe. The Big Jim claims were transferred by that company to United Eastern in 1917, in return for shares in the United Eastern company. In 1924, United Eastern closed the property because of exhaustion of the reserves, and it has been idle since. Striking of ore at a depth of 1,000 ft. in the Tom Reed shaft, northwest of the Big Jim, has evidently encouraged the company to return to the district, after operating a small silver-lead mine in the Patagonia area, Santa Cruz County, Ariz. At present plans call for deepening the Big Jim shaft from the 650 level, where it is now developed, and driving a crosscut in the direction of the Tom Reed ground. The United Eastern mill and tramway were included in the transaction, so that Big Jim will be in a position to produce as soon as ore is struck. John Henderson is in charge of operations.

■

Premier Added to Life in 1929

Development of ore in the Premier Gold property, near Stewart, B. C., fell only 37,000 tons short of equaling output in 1929, despite the tendency of the orebodies to disappear at depth. Ore was cut on the No. 5 level, but development failed to add to reserves on the No. 6 level. Developments in other parts of the mine have been fairly successful, considering the few remaining favorable areas, according to H. A. Guess, managing director of the company. The total new ore found in 1929 was 229,805 tons of silver-gold ore, compared with only 97,477 tons found in 1928. Total reserves of broken, assured, and probable ore are put at 419,000 tons, averaging 0.37 oz. of gold and 9.86 oz. of silver.

■

Four States in Safety Meet

A mine rescue contest by representatives of mining companies in four states—Arkansas, Oklahoma, Missouri, and Kansas—will be held at Joplin, Mo., on May 24. The contest is the result of a meeting of mine inspectors and safety engineers of the Tri-State lead-zinc district at Joplin recently. A committee composed of Frank Fenix, M. D. Hay, James Sherwood, and Claude Speegle, mine inspectors of the several states, has been appointed to make arrangements for the contest.

■

Complete Raise at Toric

A raise has been put up from the main tunnel to the surface at the Toric mine, near Alice Arm, B. C., by Howe Sound, which has the property under option, and it is in ore for the entire distance. A winze has also been sunk for 200 ft. from the tunnel in ore, and will be continued to 250 ft. Exploration will then be undertaken at that depth. To date a fairly large body of silver ore has been proved at the property. Fire destroyed the bunkhouse at the mine on March 1, but accommodations have been found in the neighborhood for the 25 men employed, and the work has not been affected.

■

Sue Over Sierra County Area

Roman Group Mining has filed suit in the district court at Reno, Nev., against Big Avalanche Mining to recover mine claims and an accessory mill site in Sierra County, Calif. The property carries silver and gold, associated with galena.

■

C. M. & S. Options Mineral Dyke

Consolidated Mining & Smelting has optioned the Mineral Dyke group of four claims, between Kootenay and Crawford Bays, Kootenay Lake, B. C., and has built a camp. Development will start as soon as the weather permits. Platinum is the chief metal contained in the deposit.

■

Topographic Map for Kentucky

An appropriation of $100,000 annually for two years has been made by the General Assembly of Kentucky, beginning as of April 1, 1930, to be used for co-operative topographic mapping of the state. A similar appropriation will be made by the U. S. Geological Survey. About 70 per cent of the state has been topographically surveyed, and the remainder is expected to be completed with the $400,000 made available.

Tonopah Ex., Only Company at Work in Camp, Not to Close

Reno, Nev., March 19.—Tonopah Extension, the only company still at work in the Tonopah district of Nevada, shipped 32 bars of silver-gold bullion yesterday, weighing 65,170 oz. and valued at $38,500. This shipment represents the clean-up for the first half of March and is the largest output from the mine in more than two years. The company has no intention of closing, despite the low price of silver—42.5c. an ounce. In fact, deep-level pumping has been started to permit development of the mine at depth. Closing of Tonopah Extension would mean flooding of the mines of the entire district.

In addition to Tonopah Extension, some production is coming from the district from leasing operations in the upper levels of some of the mines where water causes no interference. These operators can still ship ore to Tonopah Mining's Desert mill, as the company has decided to continue operation of the plant, even though the mine is closed. Suspension of mining operations was due entirely to market conditions, as a large tonnage of ore still remains in the property. The management evidently believes that the price of the metal will improve. Tonopah Belmont and West End Consolidated have also closed their properties.

■

Rhodesian Drilling Results

Several diamond drill holes, listed below, have struck ore in Northern Rhodesia within the last six or eight weeks. Of these, the most important probably are Nos. 32 and 33 at the Chingola property of Rhodesian Congo Border Concession, and Nos. 20, 25, 26, 28, and 30 at Mufulira. The R.C.B.C. holes, together with No. 15, indicate a new and entirely separate orebody from that in which about 35,000,000 tons of 9 per cent copper have been proved, near the N'Changa boundary. The Mufulira holes have added to the width of the central portion of the orebodies at that property. Details follow:

Hole Number	Depth Struck, Ft.	Width, Ft.	Copper, Per Cent
Mufulira			
20	1,526	20	8.19
	1,695	35	4.58
	1,834	31	2.97
25	364	8.5	2.94
26	373	11.8	3.20
28	730	110	3.58
	904	7.5	2.93
30	633	24.5	3.07
	717	106	4.62
Chingola (R.C.B.C.)			
32	440	30(*d*)	4.75
33	215	35(*d*)	10.4
		25(*d*)	6.4
Mindola (N'Kana)			
20	387	22(*d*)	4.45
21	482	17.5	5.73
22	346	18	4.66
Baluba (Selection)			
10	796	5.8	4.83
11	348	36	2.62
Roan Antelope Extension			
11	591	47	5.51
N'Changa			
B37	110	70(*d*)	4.2
Chambishi			
32	758	34.9	4.14

(*d*) Drill-hole thickness only. Other widths are true widths, calculated on the dip of the lode.

The two results given for No. 33 at Chingola represent the core and sludge results, respectively.

CABLES

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FROM CORRESPONDENTS IN THE PRINCIPAL MINING CENTERS

Carl Davis Expects Roan and N'Kana to Start in 1932

London, March 18.—Carl R. Davis, director of several of the Rhodesian copper companies, has just returned to London after an extended visit to the mines in Northern Rhodesia. He expects Roan Antelope and N'Kana, Bwana M'Kubwa's big mine, to begin production by the end of 1931 or early in 1932. In regard to native labor, which has been the most problematical factor in considering the future of the Rhodesian mines, Mr. Davis says that the present prospect is that the native labor supply will keep pace with the demand.

. . . . Completion of the Kafue bridge on the N'Kana spur line is expected in April. Erection of the N'Kana metallurgical plants, with a capacity of 6,000 tons of ore daily, will start immediately thereafter. A smelter is included in the plans. A unit of the N'Kana power plant is already in operation. Mr. Davis seems to be greatly impressed by the vast extent of the N'Kana orebody. He says that so much ore is proved already that little reason exists for further drilling except occasional random holes to extend the known limits and determine the trends of the ore. Recent holes at this property have narrowed the gap between the main orebody and the Mindola section and have also extended the Mindola orebody further north. Nearly 9 miles of ore has now been proved, with only a small break between the two known orebodies. Operating costs at the leaching plant of Bwana M'Kubwa, on the company's Bwana mine, have been greatly reduced and the property is earning excellent profits with the present high price of copper.

. . . . Although Roan Antelope has practically ceased drilling on its original property as the orebody has been definitely outlined, several drills are still in operation on the adjoining Roan Extension area, and a large additional tonnage is being developed there. Recent holes have indicated higher grades and better widths than the average in the Roan property, where 75,000,000 tons of 3.3 per cent copper have been proved. Progress in plant construction is reported excellent.

. . . . Completion of Rhodesian Congo Border Concession's NE 33 hole proves that either an important new orebody has been found at Chingola or that the remarkable deposit on the N'Changa Extension area continues for 9,000 ft. to the west. Quarterly reports of N'Changa Copper and Rhodesian Congo Border, to be issued early in April, are awaited with interest, as exploration on one of the eastern grants of R.C.B.C. is said to have disclosed an excellent outcrop, and further development is expected.

. . . . Luiri Gold, Northern Rhodesia's new gold mine, recovered £2,637 in February, from the treatment of 1,056 tons of ore, and is said to be doing still better in March. Capacity of the initial cyanide unit is only 50 tons daily.

. . . . C. B. Kingston, consulting engineer for Globe & Phoenix Gold Mining, is reported to have gone to Northern Rhodesia to investigate a proposition for an American company.

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Competition and Conservation Seen as Problems by Sale

London, March 17.—C. V. Sale, chairman of the British Metal Corporation, at the annual meeting of the company made several interesting statements in regard to the non-ferrous metal situation, in which his concern has so large an interest. He said large stocks of metal are being held, principally against forward sales. The wide range of production and prices indicates the deadly struggle that is being waged for control of the markets. Supplies, he said, can be regulated only with great difficulty and producers have to bear the burden of the stocks if they would prevent weakness in the situation. Conservation of natural resources is becoming a world-wide question. In regard to the tin situation, producers hope by curtailing production to restore the market to a fair and reasonable level. The price of the metal, although weak, was believed to have reached the bottom.

. . . . This opinion in regard to tin has been confirmed by recent purchases of large blocks of tin shares by important interests. Malayan companies have been particularly popular. Prices for shares have been steady in spite of the low price of the metal. The statistical situation is improving, although stocks are still high, and with the curtailment now being put into effect tin producers feel that the situation will right itself in due course. One Eastern company is said to be increasing its capital by £100,000, possibly for a new dredge.

. . . . Copper continues weak on the standard market. The large stocks held by American producers puzzle London dealers, who fail to understand the maintenance of the price at 18c. a pound. They believe that a break is inevitable and that it would not necessarily react to the disadvantage of the large mining companies, as they feel that lower prices would stimulate consumption. In the meanwhile, consumers of copper here are buying hand-to-mouth in the expectation of lower prices.

. . . . Great Tanami Gold Mines Syndicate is reported to have been offered £4,000 in cash plus one-twelfth interest in the shares of all companies formed to work its gold concession in Central Australia, 400 miles north of Alice Springs. Melbourne and Sydney people are interested in this field. The syndicate has a capital of £20,000 in 400 shares, of which only 187 are issued and fully paid.

Possible Additions to Frood Discussed at Inco Meeting

Toronto, March 19.—The official estimate of high-grade ore below the 1,400 level of International Nickel's Frood mine, near Sudbury, included only ore definitely in sight, R. C. Stanley, president of the company, stated at the annual meeting yesterday. The figure published in the annual report was 43,000,000 tons, averaging 6.01 per cent, combined nickel-copper. Only limited development has been done on the 3,100 level of the mine, so that the tonnage at depth was included in this estimate only in part. The crosscut on the 3,100 level showed 150 ft. of ore, averaging 20 per cent copper, 1.5 per cent nickel, and high precious-metal values, indicating that when this level is completely developed, the grade for the tonnage below the 1,400 level may have to be revised upward. Diamond drilling has shown continuation of ore below 3,100 ft.

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Labor Situation on Rand Better; Visitors Arrive for Congress

Johannesburg, March 20.—The native labor supply for the Witwatersrand gold mines is showing the usual seasonal improvement, and production returns will probably reflect the improved situation. Publication of the Crown Mines annual report shows that about 2,000,000 tons of ore was developed during 1929. As production was 2,643,000 tons, reserves showed a slight decline to 10,841,400 tons, of an average grade of about 6.6 dwt. per ton. Crown Mines, because of the low grade of its ore, is not as large a gold producer as either Government Areas or New Modderfontein, but from the standpoint of tonnage handled and miles of workings driven, it is the world's leading gold mine. The profits last year were £946,539. East Rand Proprietary, which at the end of 1928 had only about two years of ore in sight, improved its position greatly during 1929. Installation of the large new electric hoists at the East Geduld property, on the East Rand, where a vertical shaft is now being sunk, has been started. The hoists have a capacity of 2,000 tons of ore daily. Ore reserves at the property at the last official estimate were 1,900,000 tons of an average value of 6.6 dwt. per ton.

. . . . All arrangements for the third triennial British Empire Mining Congress have been completed. Within the next few weeks about 145 visitors from all parts of the world are expected to arrive at Cape Town and Durban en route to the congress. The annual meeting of the Transvaal Chamber of Mines will be held on March 24, just preceding the congress.

. . . . Fresh discoveries of diamonds in British South West Africa are reported. Redrafting of the mining laws of Southern Rhodesia is approaching completion. Asbestos and gold are the province's chief mineral products.

MARKET AND FINANCIAL NEWS

Improvement in Demand Fails to Steady World Position of Zinc

INTERNATIONAL METAL SERVICE, LTD.
LONDON

THE hopes entertained earlier in the year that the worst had been reached have turned out to be illusory, the quotation for zinc having continued its downward course until reaching a figure not seen since 1908. Consumptive demand has been better, but, be that as it may, it has been spasmodic and caused only momentary checks in the falling movement. As soon as the moderate buying waves subsided, the relentless pressure of offers of metal in excess of the market's capacity of absorption was resumed. Despite this, and the very obvious state of nervousness at present in evidence in the market, the general impression in producing circles is that the worst is passed.

The fall in lead is expected to cut off certain production of both lead and zinc concentrate at high-cost centers. As to this, however, if Mexican and Australian production is to continue on the present large scale, one cannot but be apprehensive of the effect of the potential big increase in production in Canada.

As regards Australia, the largest addition to the Broken Hill output will be in Tasmania as the result of the operating of the mines on that island owned by the Electrolytic Zinc Company of Australia. The Continent views with mixed feelings the heavy stocks of concentrate in Australia. Some smelters are alarmed lest the British government should instruct its selling agents to realize on the tonnage for whatever it will fetch in the open market on the termination of the Board of Trade contract on June 30 and other smelters are looking forward to securing part of this Australian material for admixture purposes. Stocks at Broken Hill at the end of December last were upward of 200,000 tons, irrespective of a substantial quantity of Port Pirie, and the tonnage will certainly be greater at the end of June.

This Board of Trade contract, which was signed in 1918, has greatly benefited the Australian producers, and it has likewise helped British smelters, inasmuch as they have been supplied with their raw material on privileged terms, equivalent to a subsidy on smelting. Whether the smaller smelters in Great Britain can hold their heads above water if they have to pay open-market prices for concentrates later in the year remains to be seen. The government may be disposed to sell to British works the balance of the tonnage belonging to the Board of Trade at end of June next on the same terms as during last year. In some quarters it is held that there is not the remotest chance of the contract between the British government and the Australian producers being renewed. The various Broken Hill mining companies will feel the loss of this highly favorable contract. The slump in silver has a modest effect on their revenue, and unless lead improves to the extent of at least £2 a ton during the second half of the year, the profits of the individual companies will not make a favorable showing for the year 1930.

Whether with the advent of spring demand will broaden, time alone can show, but in the meantime the position of zinc hinges on a cessation of offerings of surplus metal.

World stocks of zinc on March 1 follow:

	Metric Tons
United States	82,300
Canada, including afloat	4,100
Germany-Poland	18,600
Belgium	11,800
France	2,800
Great Britain	5,700
Other Europe	3,200
Australia, including afloat	4,000
Far East	1,600
Elsewhere	2,000
Total	136,100

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Homestake Earnings Smaller

Operating income from the Homestake Mining gold property, at Lead, S. D., was $2,473,196 in 1929, compared with $2,897,230 in 1928. The decrease resulted from higher operating costs, which, in turn, reflected the increased amount of development work done. Net income, after depreciation and depletion, was $1,044,070. Production was $6,517,838.

E.&M.J. Weighted Index of Non-Ferrous Metal Prices

100 Is Composite for 1922-3-4

1920	130.92
1921	80.80
1922	93.94
1923	103.43
1924	102.63
1925	111.74
1926	107.74
1927	97.54
1928	99.78
1929	110.33

	1928	1929	1930
January	97.54	106.86	102.94
February	96.73	110.37	102.28
March	96.22	122.71	.....
April	97.14	116.36	.....
May	99.05	110.03	.....
June	100.16	109.66	.....
July	99.69	109.58	.....
August	99.85	109.81	.....
September	100.53	109.29	.....
October	102.34	108.52	.....
November	103.83	106.09	.....
December	104.28	104.75	.....

Financial Notes

TINTIC LEAD spent $277,823 in development of the Horn Silver mine, Beaver County, Utah, during 1929. The company has cash on hand of $31,904, in addition to 446,000 unissued shares of its treasury stock, as compared with current liabilities of $9,726. Ore in transit on Jan. 1 was estimated at $6,871.

SUNSHINE MINING, operating a silver-lead property in the Coeur d'Alene district, Idaho, reports a gross income of $882,984 in 1929, and a net profit of $367,937. Production amounted to 62,392 tons of ore, containing 27.8 oz. of silver a ton, as well as 1.3 per cent lead and 0.024 per cent copper. On Jan. 1 the company had a cash surplus of $134,176. Dividends paid during the year totaled $327,540, or 22c. a share.

BENGUET CONSOLIDATED, operating gold mines in the Philippine Islands, made a net profit of 1,603,602 Philippine pesos in 1929. Production amounted to 3,028,393 Philippine pesos, from the treatment of 97,400 tons of ore. Indebtedness of its subsidiary, Balatoc Mining, has been completely discharged and two dividends have been declared. Benguet paid dividends amounting to 1,300,000 pesos, or 65 centavos a share, out of profits in 1929.

Stocks of Refined Copper Increase in February

Refined copper production, shipments and stocks, North and South America, according to the American Bureau of Metal Statistics, follow:

	December 1929	January 1930	February 1930
Production;			
Primary	126,842	123,193	109,826
Scrap	11,361	9,181	11,369
Total	138,203	132,374	121,195
Daily rate	4,458	4,270	4,328
Shipments:			
Exports	35,652	30,358	29,597
Domestic	58,150	69,932	61,879
Total	93,802	100,290	91,476
Stock end of month	171,320	203,404	233,123

Production and stocks:

	January 1930	February 1930
Production:		
U. S. mines	67,838	59,547
Blister, No. America	97,571	85,501
Blister, So. America	23,967	21,120
Refined, No. and So. Am.	132,374	121,195
World, blister basis	154,252	.....
Stocks:		
No. and So. America:		
Blister and in process	270,209	264,789
Refined	203,404	233,123
Total	473,613	497,912
Great Britain, total	8,195	9,520
Havre	4,960	5,174

Distribution of United States copper production in January and February.

	January 1930	February 1930
Porphyry mines	25,914	22,137
Lake mines	6,894	6,885
Vein mines	28,807	24,325
Custom ores	6,223	(a) 6,200
Total crude production	67,838	59,547
Daily rate	2,188	2,127
Imports in ore and matte	9,068	.....
Blister from scrap	5,731	.....
Smelter production	84,451	.....

(a) Partly estimated.

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Federal Earnings Mounted With Higher Prices

Before depletion and depreciation, Federal Mining & Smelting made net earnings of $2,520,687 in 1929, compared with earnings of $2,058,291 in 1928. Higher average prices for lead and zinc, combined with a slightly greater output, were the causes of the increase. At the end of 1929, the company's balance was $7,000,312, compared with $4,580,419 at the end of 1928. Gross value of production was $10,300,978, and total costs were $7,618,171. Production of lead was 45,744 tons in 1929, compared with 44,022 tons in 1928, and production of zinc was 47,469 tons compared with 42,699. Ore mined amounted to 1,250,380 tons, of which 380,660 tons came from the Morning mine, in Idaho.

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Bunker Hill Earnings Show Little Change From 1928

Operating surplus of Bunker Hill & Sullivan, after depletion, depreciation, and taxes, amounted to $2,329,046 in 1929, compared with $2,255,749 in 1928. Mining costs were somewhat increased during the year because of a large development program, but the higher metal prices offset this increase. Net smelter returns for the company's production of lead, silver, zinc, and gold were $4,659,910, compared with $4,366,032. Production of concentrate was 75,451 tons, averaging 56 per cent lead, 5 per cent zinc, and 23 oz. of silver to the ton. From the company's smelter at Kellogg, 69,295 tons of lead, 8,544,009 oz. of silver, 1,209,789 lb. of copper, and 35,888 oz. of gold were produced in treating company and custom ore. At the end of the year the balance was $44,192,523.

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Noranda's Net Income for 1929 Shows Marked Increase

Net income of Noranda Mines, after depreciation and taxes, was $4,287,173 in 1929, compared with $1,360,256 in 1928. Total value of metal production from the property at Rouyn, Que., was $10,947,289 and miscellaneous income was $546,069. Expenditures were $4,592,297 for metal production. Administrative and general expenses were $192,619. Surplus account was $5,647,429 at the end of the year, from which $1,679,829 was deducted for the first dividend, payable Jan. 2, 1930. Dividends at the rate of 75c. quarterly are being continued. Production of copper at the smelter was 51,625,478 lb. of blister from 428,221 tons of ore, of which 384,300 tons came from the company's mine.

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C. & A. Earnings Unchanged on Smaller Sales in 1929

Net income of Calumet & Arizona Mining, Arizona copper producer, was $7,733,603 in 1929, after depreciation and taxes compared with $7,770,354 in 1928. Both these figures are based on the present capital of 842,857 shares, representing the combined Calumet & Arizona and New Cornelia companies. The failure to reflect the increase in the copper price, despite a production equal to that in 1928, results from the fact that sales in 1929 were only 89,054,392 lb. of copper, compared with sales of 144,536,522 lb. in 1928. Production of copper in 1929 was 127,139,117 lb., compared with 129,728,103 lb. in 1928. Silver production was 1,688,376 oz. and gold production was 54,672 oz.

Current assets of the company are given as $11,703,301, and investments, at cost, as $3,905,947. Current liabilities are given as $3,217,410. The increase in the stocks of metal held are reflected by the increase in the value of metals on hand and in process, at cost, from $1,701,612 in 1928 to $6,324,308 in 1929. The company's surplus is given as $62,955,736 at the end of 1929, as compared with $63,332,779 at the end of 1928.

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Alaska Juneau Near Dividend Stage, Bradley Declares

Dividend payments beginning in the second quarter of 1931 may be made by Alaska Juneau Gold, low-cost Alaskan producer, if the present earning rate is maintained, according to F. W. Bradley, president of the company, in the annual report. In 1929 the company made a net profit after all charges, except depletion, of $1,025,208, as compared with $781,106 in 1928. Production was $3,627,247, the highest in the company's history. The average milling rate was 10,598 tons of ore daily in 1929, and the average recovery was $0.89 a ton. The total funded debt of the company on Dec. 31 had been reduced to $893,400. Profits in 1930 should retire this outstanding debt. A surplus of $436,289 was shown in the 1929 report, the first in many years.

Mining Company Dividends and Yields for March, 1930

Companies in the United States	Situation	Per Share	Total Disbursements	Annual Per Cent Yield
American Metal	Various	$0.75 Q	$651,138	6.5 j
American Metal, 6% pfd	Various	1.50 Q	103,014	5.2 j
American Smelting & Refining, pfd	Various	1.75 Q	875,000	5.0 j
Bunker Hill & Sullivan, s. l	Idaho	0.50 MX	245,250	7.5 j
Calumet & Arizona, c	Arizona	1.50 Q	1,314,285	7.7
Calumet & Hecla, c	Michigan	1.00 Q	2,005,502	14.2
Federal Mining & Smelting, pfd	Idaho, Okla	1.75 Q	126,000	7.0 j
Golden Cycle, g	Colorado	0.04 Q	60,000	10.6 j
Homestake Mining, g	S. Dakota	0.50 M	125,800	8.8 j
Hecla Mining, l. s	Idaho	0.25 Q	250,000	8.3
Inland Steel	Minn	1.00 Q	1,200,000	4.7
Isle Royale, c	Michigan	0.50	75,000	.....
Mayflower Associates, h	Various	0.50 I	150,000	.....
Mohawk Mining, l. s	Michigan	1.50 Q	172,500	13.3
National Lead	Various	4.25 QX	1,316,782	4.5 j
National Lead, pfd "A"	Various	1.75 Q	426,433	5.0 j
Nevada Consolidated Copper	Nev., Ariz., N. M.	0.75 Q	3,641,332	10.7 j
Republic Iron & Steel	Various	1.00 Q	859,959	5.3
St. Joseph Lead	Various	0.75 QX	1,463,647	6.0 j
Sherman Lead	Idaho	0.01 I	36,750	.....
Tennessee Copper & Chemical	Tenn	0.25 Q	210,767	7.1 j
Texas Gulf Sulphur	Texas	1.00 Q	2,540,000	6.5 j
Tintic Standard, s. l. c	Utah	0.30 QX	345,900	.....
United States Steel	Various	1.75 Q	14,229,250	4.4 j
Utah Copper	Utah	4.00 Q	6,491,980	.....
Companies in Other Countries				
Chile Copper	Chile	0.875 Q	3,863,559	.....
Hollinger Consolidated Gold	Ontario	0.05 M	246,000	10.4 j
International Nickel, n. c	Ontario	0.25 Q	2,947,161	2.5
Lake Shore, g	Ontario	0.30 Q	300,000	5.2 j
McIntyre-Porcupine, g	Ontario	0.25 Q	199,500	5.9 j
Total			$46,472,509	

s, silver; l, lead; c, copper; n, nickel; g, gold; h, holding company; Q, quarterly; M, monthly; X, extra; I, initial; j, based on dividends for last twelve months.

Calumet & Hecla Net Gains 65 Per Cent in 1929

Net profit, after depreciation, depletion, and taxes, of Calumet & Hecla showed a gain of 65 per cent in 1929, the total being $5,326,932, as compared with $3,110,574 in 1928. Total income for 1929 was $21,208,985, and disbursements were $12,152,265, leaving an operating profit of $9,056,720 before depreciation and depletion. The company has current assets of $16,028,627; investments of $1,832,608; current liabilities of $1,864,287, and a total surplus of $3,940,204. Dividends paid in 1929 were $9,024,759, compared with $5,013,755 paid in 1928. Copper production statistics follow:

	1928	1929
Mines, lb.	91,308,000	90,319,000
Mines, cost per lb.	$0.1010	$0.1143
Dredges, lb.	29,896,000	33,511,000
Dredges, cost per lb.	$0.0595	$0.0562

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Financial Notes

ARIZONA COMMERCIAL had a net income, before depletion, of $161,403 in 1929, compared with $173,611 in 1928. Copper production from the property at Globe, Ariz., was 3,800,456 lb., compared with 4,665,605 lb. in the preceding year. Surplus on Dec. 31, 1929, was $810,180.

CONIAGAS MINES, LTD., owning silver-cobalt properties near Cobalt, Ont., reports a net profit, before depreciation or depletion, of $99,811 in 1929. Income from leasers on the company's mines totaled $67,099. The company still has a substantial interest in the Coniaurum and March Gold properties at Porcupine.

ISLE ROYALE COPPER made a net profit, after depreciation and depletion, of $197,469 in 1929, compared with $65,878 in 1928. Gross income was $1,570,499, compared with $1,964,277. Cost of producing copper, before depreciation or depletion, increased from 12.63c. a pound to 14.01c. a pound. Production was 10,864,085 lb.

DAYROCK MINING, operating a silver-lead property in the Coeur d'Alene district of Idaho, reports income of $186,849 in 1929, before depreciation, depletion, or taxes. Dividends paid amounted to $203,136. The company's surplus is put at $896,588. Production in 1929 was 37,254 tons of ore, averaging 10.1 per cent lead, 1.8 per cent zinc, and 7.9 oz. of silver.

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Tri-State Concentrates

Joplin, Mo., March 15, 1930

Blende	
High	$38.55
Premium and Prime Western, 60%..	37.00
Fines and slimes, 60% zinc	36.00
Average settling price, all	37.23
Galena	
High	$72.70
Basis 80% lead	62.50
Average settling price	67.75

Good Business in Lead at Lower Prices—Copper Holds Steady—Zinc Down

New York, March 19, 1930.—A sharp decline in lead took place in the last two weeks, which was easily the feature in the market for non-ferrous metals. Excess production abroad was the cause of the general break in lead quotations. The February copper statistics showed another big increase in stocks of refined, but those in control of the situation exhibited no wavering in the position they have taken of maintaining the price at the present level. Zinc prices developed further weakness on continued selling pressure. Tin also gave a poor account of itself, selling at a new low for the movement. Buying by China, as well as covering by shorts, resulted in a steadier market for silver. Platinum was reduced in price. With the threat of a higher duty on antimony removed, the premium for spot and near-by material disappeared.

Copper Demand Fair

Sales continue to be confined to immediate and prompt shipment metal. The steady increase in stocks in the hands of producers naturally offers no inducement to consumers to take on copper except to cover actual needs. The rate of buying has been fair, holding at about the same level as earlier in the year. Blister stocks in the United States in February decreased 5,420 tons, but refined stocks were up 29,719 tons. Rate of mine production was only slightly lower than in the preceding month. Shipments were disappointing.

Sharp Drop in Lead

Selling pressure and lower prices abroad, resulting from excess production of lead, was followed by a drastic reduction in prices here. In New York the price settled at 5.50c., which was also the contract price of the A.S.&R. The St. Louis market closed at 5.40c. Good buying took place at the lower levels. Domestic shipments of lead in February were good, amounting to 64,804 tons. Stocks of refined lead, including antimonial, in the United States and Mexico on the last day of February, totaled 49,904 tons, against 56,570 tons a month previous. Latest statistics covering European production reveal that the output of lead abroad has actually gained since the first of the year. A meeting of producers now being held in London is taking up the matter of curtailing production, and it seems probable that some agreement will be reached soon to reduce the output.

Zinc Unsettled

Zinc sold down to 4.90c. for prompt and near-by shipment. With the demand subnormal, and no appreciable change in the rate of production, the future of the market appears uncertain. The undertone remains easy. Stocks of zinc in the United States on March 1 were 90,703 tons, against 87,933 tons on February 1.

Tin Prices Decline

Buying of tin by domestic consumers was disappointing, and with the situation abroad no better than here, prices developed further weakness. Sales were recorded as low as 35¼c. Straits shipments for March are expected to reach 8,000 tons, and it is felt that a good tonnage will be placed in warehouses in an effort to steady the situation.

Silver Advances

Buying by China and covering by shorts has steadied the market for silver, the closing quotation in New York being 42⅛c. Production of silver in the United States in February was 4,713,000 oz., against 4,753,000 oz. in January. Silver production in 1929, covering about 88 per cent of the world's output, was 232,885,000 oz., against 227,940,000 oz. in 1928, 223,837,000 oz. in 1927, and 222,874,000 oz. in 1926. Of the total quantity produced last year, Mexico is credited with 108,701,000 oz.

Other Metals

Quotations cover large wholesale lots, f.o.b. New York, unless otherwise specified. London prices are according to latest mail advices.

ALUMINUM—Per lb., 99 per cent plus grades, price of leading interest, 24.30c. Outside market, 99 per cent plus, 24.30c., 98-99 per cent, 23.90c. London, 98 per cent, quoted at £95 per long ton, less 2 per cent for domestic consumption.

ANTIMONY—Per lb., duty paid: Chinese brands, spot, 7⅞c.; futures, 5⅞c., in bond. Cookson's "C" grade, spot, 13¼c. Chinese needle, lump, 8c. Standard powdered needle, 200 mesh, 10c.

BISMUTH—Per lb., in ton lots, $1.20 Smaller lots $1.35 and up. London 5s.

CADMIUM—Per lb., 80@85c. London, 3s. 11d.@4s. for prompt.

CHROMIUM—Per lb., 97@98 per cent grade, 95c.@$1.

COBALT — Per lb., f.o.b. Canadian works: Shot or rondelles, 97@98 per cent, $2.50. Contract sales booked at discounts, depending on quantity. Black oxide, 70 per cent, $2.10. London, nominal, 10s. for metal in small lots, 8s. for black oxide; 8s. 10d. for gray.

[1]GERMANIUM DIOXIDE—Per gram in 200- to 300-gram lots, $3.50.

IRIDIUM—Per oz., $175@$180 for 98 @99 per cent sponge and powder. London, £36@£38.

Daily Prices of Metals

Mar.	Electrolytic Copper	Straits Tin	Lead		Zinc
	Refinery	New York	New York	St. Louis	St. Louis
6	17.775	36.00	5.85	5.70	5.00
7	17.775	36.25	5.75	5.60	5.00
8	17.775	36.25	5.60	5.45	5.00
10	17.775	36.125	5.50	5.375@5.40	5.00
11	17.775	36.625	5.50	5.375@5.40	4.95@5.00
12	17.775	36.50	5.50	5.375@5.40	4.95@5.00
Av'ge	17.775	36.292	5.617	5.485	4.992
13	17.775	36.125	5.50	5.40	4.95@5.00
14	17.775	36.00	5.50	5.40	4.95
15	17.775	36.00	5.50	5.40@5.45	4.95
17	17.775	35.75	5.50	5.40	4.90@4.95
18	17.775	36.00	5.50	5.40@5.45	4.90@4.95
19	17.775	36.00	5.50	5.40	4.90
Av'ge	17.775	35.979	5.500	5.408	4.938

Average prices for calendar week ended March 8, 1930, are: Copper 17.775c.; Straits tin, 36.625c.; New York lead, 5.867c.; St. Louis lead, 5.717c.; zinc 5.017c.; and silver, 40.479c.

Average prices for calendar week ended March 15, 1930, are: Copper, 17.775c.; Straits tin, 36.229c.; New York lead, 5.500c.; St. Louis lead, 5.398c.; zinc, 4.971c.; and silver, 41.500c.

The above quotations are our appraisal of the major markets for domestic consumption based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

Copper, lead, and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

In the trade, copper prices are quoted on a delivered basis; that is, delivered at consumer's plant. As delivery and interest charges vary with the destination, the figures shown above are net prices of refineries on the Atlantic seaboard. Delivered prices in New England average 0.225c. per pound above those quoted.

Quotations for copper are for the ordinary forms or wirebars and ingot bars. For ingots an extra 0.05c. per pound is charged; for slabs, 0.075c.; and for cakes, 0.125c. up, depending on weight. Cathodes are sold at a discount of 0.125c. per pound.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York is now quoted at 0.35c. per pound above St. Louis, this being the freight differential. The contract price for High-Grade zinc delivered in the East is 1c. above the St. Louis price for Prime Western.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

Silver, Gold, and Sterling Exchange

Mar.	Sterling Exchange "Checks"	Silver		Gold London	Mar.	Sterling Exchange "Checks"	Silver		Gold London
		New York	London				New York	London	
6	$4.85 11/16	40 5/8	18 3/4	84s10½d	13	$4.85 7/8	41 5/8	19 1/4	84s11¼d
7	4.85 5/8	41 1/4	19 1/16	84s10¾d	14	4.85 3/4	41 1/2	19 1/16	84s11¼d
8	4.85 13/16	40 7/8	19 3/16	.....	15	4.85 5/8	41 7/8	19 1/4	.....
10	4.85 3/4	41	19 1/16	84s11¼d	17	4.85 13/16	41 7/8	19 1/4	84s11¼d
11	4.85 3/4	41 1/4	19 3/16	84s11 d	18	4.85 3/4	41 3/4	19 3/16	84s10⅞d
12	4.85 3/4	41 3/4	19 1/4	84s11¼d	19	4.85 3/4	42 1/8	19 5/8	84s10¼d

Average for the week ended March 12: Silver, 41.125c.; Sterling Exchange, $4.85729.

Average for the week ended March 19: Silver, 41.792c.; Sterling;Exchange,;$4.85760.

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of silver, 999 fine. London silver quotations are in pence per troy ounce of bar silver, basis of 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command nine-thirty-seconds cent premium.

London

Mar.	Copper Standard		Electrolytic	Tin		Lead		Zinc	
	Spot	3 M		Spot	3 M	Spot	3 M	Spot	3 M
6	68	67 3/4	83 1/2	161 1/2	163 3/4	19 1/8	19 1/8	18 1/16	18 11/16
7	67 3/8	66 5/8	83 1/2	159 1/4	161 1/2	18 1/2	18 3/4	17 3/8	18 3/8
10	68	66 5/8	83 1/2	161 1/2	163 3/4	18 7/16	18 3/4	18 1/16	18 11/16
11	69 3/4	67 1/2	83 1/2	163 3/4	165 1/2	18 7/16	18 3/4	17 15/16	18 1/2
12	69 3/4	68 1/4	83 1/2	166 1/4	168 1/4	18 7/16	18 3/4	18 3/16	18 11/16
13	69 1/4	67 1/2	83 1/2	161 3/4	164	18 1/2	18 3/4	17 7/8	18 3/8
14	69 1/8	67 1/4	83 1/2	161 1/4	163 1/2	18 1/2	18 3/4	17 7/8	18 3/8
17	69	66 7/8	83 1/2	160 3/4	162 7/8	18 1/2	18 3/4	17 15/16	18 7/16
18	68 1/4	66 7/8	83 1/4	162	164 1/2	18 9/16	18 3/4	18 1/4	18 5/8
19	68	66 7/8	83 1/4	161 1/2	163 3/4	18 1/2	18 3/4	18 1/4	18 5/8

Prices for lead and zinc are the official prices for the morning session of the London Metal Exchange; prices for copper and tin are the official closing buyers' prices. All are in pounds sterling per long ton (2,240 lb.).

LITHIUM—Per oz., 98@99 per cent grade in 10- to 25-lb. lots, $3.

MAGNESIUM—Per lb., single orders for spot metal: 8-lb. ingots (3x3x15 or 16 in.), 95c.@$1.05, depending on quantity; 2½- or 3-lb. sticks (1⅛ in.) 90c.@$1.10, depending on quantity; 10-oz. sticks (1x12 in.), 80c.@90c. Discounts up to 20 per cent on larger orders or contracts. London 3s. 3d.@ 3s. 6d. for 99 per cent ingots or sticks.

MOLYBDENUM—Per lb. in 50- to 100-lb. lots, 99 per cent, $11; 97 per cent, $9. (Usually sold as calcium molybdate or ferromolybdenum, which see.)

NICKEL—Per lb., ingot, 35c.; shot 36c.; electrolytic, 35c. (99.90 per cent), for single lots of spot metal. London, per long ton, £170@£175.

OSMIUM—Per oz., $70. Nominal. London, £13 15s.

PALLADIUM—Per oz., $30@$32; London, £6@£6 10s.

PLATINUM—Official price quoted by the leading interest on small miscellaneous orders for refined metal, per oz., $55. Transactions between dealers and refiners in the outside market are commonly reported at several dollars less.

London, per oz., £11 10s. for refined; crude and scrap, nominal at £10.

QUICKSILVER—Per 76-lb. flask, $118 @$120. Market dull and prices on round lots nominal. San Francisco wires $122. London steady, with offers at £22 15s.

RADIUM—Per mg. radium content, $70.

RHODIUM—Per oz., $45@$50. Nominal. London, £11@£12.

RUTHENIUM — Per oz., $40@$45. Nominal. London, £9 10s.

SELENIUM—Per lb. in 500-lb. lots; Black, powdered, amorphous, 99.5 per cent pure, $2. London, 7s. 8d.@ 7s. 9d.

TANTALUM — Per gram: Bar and heavy sheet, chemically pure, 12.8c.; tantalum powder, 8.2c.

TELLURIUM—Per oz., 15@18c.

THALLIUM METAL—$12.50@$15 per pound.

TITANIUM—Per lb., 80@90 per cent grade, $5.

TUNGSTEN POWDER—Containing 98 per cent tungsten, per lb., $1.70@$1.75.

VANADIUM—88@92 per cent grade, $4.50@$5 per lb. of V contained.

Metallic Ores

ANTIMONY ORE—Bolivian ore, 60 per cent metallic antimony, $1.30 per short ton unit, c.i.f. New York.

CHROME ORE—Per long ton, f.o.b. Eastern shipping points, Indian and Rhodesian ores, $21.50 for 46@47 per cent Cr_2O_3 ore, and $24 for 50@51 per cent ore. New Caledonian ore, high-grade, $25.

IRON ORE—Per long ton, lower Lake ports. Lake Superior ores:

Mesabi, non-bessemer, 51½ per cent

iron, $4.50. Old Range, non-bessemer, $4.65.

Mesabi, bessemer, 51½ per cent iron, $4.65. Old Range, bessemer, 51½ per cent, $4.80.

Eastern ores, cents per unit, delivered at furnaces: Foundry and basic, 56 to 63 per cent, 9c.

Foreign ores, alongside docks Atlantic ports, cargo lots cents per unit:

North African, low-phosphorus, 12c.

Spanish and North African basic, 55@60 per cent, 10½c. Nominal.

Swedish foundry or basic, 66@68 per cent, 10½c.

Newfoundland foundry, 55 per cent, 8½@9c. Nominal.

MANGANESE ORE—Per long-ton unit of Mn, c.i.f. North Atlantic ports, cargo lots. Exclusive of duty: Brazilian, 46@48 per cent Mn, 29@31c.; Indian, 48@50 per cent, 30@32c. Caucasian, 52@55 per cent, 30@32c.; Cuban, minimum 47 per cent, 32c.; Chilean, 47 per cent, minimum, 31c.

Per ton in carload lots:

Chemical grades, powdered, coarse or fine, minimum 80 per cent MnO_2, Brazilian or Cuban, $60. Javan or Caucasian, 85 per cent minimum, $65. Domestic, 70 to 72 per cent, $40@$50, f.o.b. mines.

TANTALUM ORE—Per unit of Ta_2O_5, basis 60 per cent ore, $13.

TITANIUM ORE—Ilmenite, per gross ton, 50 per cent TiO_2, f.o.b. Atlantic seaboard, $9.50@$11, according to grade and impurities. Low-grade domestic, 32 to 35 per cent, about $7@$8 per gross ton. Rutile, per lb., guaranteed minimum 94 per cent concentrate, 10c. in carload lots.

TUNGSTEN ORE—Per short ton unit of WO_3 N. Y.; Wolframite, $14.50 for future delivery. Demand is slow. Bolivian scheelite is quoted at $15, Mar.-Apr. shipment. Domestic scheelite, $16.50.

VANADIUM ORE—Per lb. V_2O_5 contained, 28c.

ZIRCON ORE—Per net ton containing 55 per cent ZrO_2, f.o.b. Atlantic seaboard, $40@$45 in 30-ton lots.

Alloys

[1]FERROCERIUM—Per lb., $6 in 100-lb. lots.

FERROCHROME—Per lb. of contained chromium, 4 to 6 per cent carbon, 11c. on requirement contracts; spot shipments 11½c. Maximum 2 per cent carbon, 17½c., contracts. Freight allowed on carload lots east of Mississippi River and north of Baltimore.

FERROMANGANESE—Per gross ton furnace: Domestic and foreign, 78@82 per cent, $94@$99. Spiegeleisen, 19@21 per cent, $34 on carload business, f.o.b. furnace.

FERROMOLYBDENUM—Per lb. of Mo, f.o.b. shipping point, 50œ60 per cent Mo, $1.20.

FERROPHOSPHORUS—Per ton, 18 per cent P, $91; electrolytic, 24 per cent, $122.50, f.o.b. *Alabama* and *Tennessee*.

FERROSILICON—Per gross ton, f.o.b. works, freight allowed on carload lots east of Mississippi River and north of Baltimore: 50 per cent, $83.50; 75 per cent, $130; 15@17 per cent, $45, f.o.b. Suspension Bridge, N. Y. Quotations for spot shipments $5@$10 per ton higher on 50 and 75 per cent grades.

FERROCARBONTITANIUM — Per ton: $160, f.o.b. producer's plant.

FERROTUNGSTEN—Per lb. of W contained, 75@80 per cent W, $1.45 f.o.b. works.

FERROVANADIUM—Per lb. of V contained, f.o.b. works, freight allowed east of Mississippi, $3.15@$3.50, depending on grade and quantity.

NICKEL SILVER—Per lb. for 18 per cent nickel Grade A sheets, 34½c.

YELLOW (MUNTZ) METAL — Dimension sheets, per lb., 25c.; rods, per lb., 22½c.

Non-Metallic Minerals

Prices received for non-metallic minerals vary widely and depend upon the physical and chemical characteristics of the commodity. Hence the following quotations can serve only as a general guide to the prices obtained by producers and dealers in different parts of the United States for their own product. In the last analysis the value of a particular non-metallic mineral can be ascertained only by direct negotiation between buyer and seller.

[1]AMBLYGONITE—Per ton, f.o.b. mines, 8@9 per cent lithium oxide, $50@$60.

ASBESTOS—Per ton: f.o.b. Quebec mines, tax and bags included, prices quoted by leading sellers for delivery on contract:

Crude No. 1, $475@$575; crude No. 2, $325@$375; spinning fibers, $150@$175; magnesia and compressed sheet fibers, $100@$135; shingle stock, $50@$85, various grades; paper stock, $35@$40; cement stock, $15@$25; short fibers, $10@$15; floats, $12@$15.

Per ton c.i.f. New York; Rhodesian crude No. 1, $400; No. 2, $325.

BARIUM CARBONATE (Witherite)—Per ton: 90 per cent, 200 mesh, $47; 100 mesh, $44.

BARYTES—Per ton: f.o.b. mines, bags extra:

Georgia: Barytes ore, crude (per long ton), $9. Washed and water floated to 97 per cent through 325 mesh, $18.

Missouri: Water ground and floated, bleached, $23, car lots, f.o.b. works. Crude ore, 93 per cent $BaSO_4$, not to exceed 1 per cent iron, $7.75@$8 f.o.b. mines.

BAUXITE—Per long ton: Domestic ore, chemical, crushed and dried, 55 to 58 per cent Al_2O_3, 1.5 to 2.5 per cent Fe_2O_3, $7.50@$8.25 f.o.b. *Alabama* and *Arkansas* mines. Other grades, 56 to 59 per cent Al_2O_3, 5 to 8 per cent SiO_2, $6.75@$8.25 f.o.b. *Arkansas* mines. Pulverized and dried, $12@$14 f.o.b. *Arkansas* mines; calcined, 78 to 84 per cent Al_2O_3, $18@$19 f.o.b. *Arkansas* mines.

Per metric ton, foreign, c.i.f. Atlantic port: Dalmatian, 50 to 55 per cent Al_2O_3, 1 to 3 per cent SiO_2, $4.50@$6.50; Istrian, 54 to 57 per cent Al_2O_3, 3 to 5 per cent SiO_2, $5.50@$7; French, 56 to 59 per cent Al_2O_3, 2 to 5 per cent SiO_2, $6@$8.

BORAX—Per lb.: Carload lots, in bags, crystals, 2¾c.; granulated or powdered, 2½c.; f.o.b. shipping point.

[1]CELESTITE—Per ton in carload lots: 90 per cent $SrSO_4$, finely powdered, $27.

CHALK—Per ton: Crude in bulk, c.i.f. *New York*, $4.75@$5.

CHINA CLAY (KAOLIN)—Per ton: F.o.b. *Virginia* mines, crude lump, No. 1, $7; crude No. 2, $5.50; washed, $8; powdered and air-floated, $8@$15; ground, $7@$15.

Florida, pressed pottery, bulk, $13; ground, No. 1, $20; No. 2, $15. Sprayed mineral flour in 100-lb. bags (bags extra), No. 1, $20; No. 2, $17.

Best grade, domestic, $16@$18, f.o.b. *Delaware* plants in carload lots.

Imported English, f.o.b. American ports; Lump, $13@$20; powdered, $40@$45.

DIATOMITE—Per short ton, f.o.b. producing plant:

Kiln-fired brick, $65; kiln-fired aggregate, ¼ in., $45; insulating powder, $25; natural aggregate, ¼ in., $18@$20; air-floated powder, $45; 80 to 85 per cent silica, 98 per cent through 200 mesh, $20 in carload lots.

EMERY—F.o.b. *Pennsylvania* and *New York* in 350-lb. kegs, per lb.: Greek Naxos, 6½c.; Turkish, 6½c.; Khasia, 6½c.; domestic, 3½c.

FELDSPAR—F.o.b. mine or grinding plant:

North Carolina, per long ton, No. 1 pottery grade, crude, $6.50@$8; No. 2, glass grades, $5.50@$6.

No. 1, pottery, 140 mesh, $16; 200 mesh, $18. No. 2, enamel, 20 mesh, $10.25@$12; 140 mesh, $13.50@$16; 200 mesh, $15@$18; all per short ton.

New Hampshire, per ton: Pottery grade, $8. Best quality lump, $8.75.

New York, per ton: f.o.b. cars, No. 1 crude, $9. Soda-potash feldspar, 140 mesh, first grade, $16 per short ton; 200 mesh, first grade, $18.

Maine, per ton: Best pottery grade, ground, $19.

FLUORSPAR — Per ton: F.o.b. *Kentucky* and *Illinois* mines:

Gravel, not less than 85 per cent CaF_2, and not over 5 per cent SiO_2, $18. Foundry lump, 85-5, $20. Ground, 95 to 98 per cent CaF_2, and not over 2½ per cent SiO_2, $32.50 in bulk; $36.50

[1]Price furnished by Foote Mineral Company, Philadelphia.

in bags or barrels. Acid lump, 98-1, $30 in car lots.

New Mexico: 85-5 gravel, $16.50; 85-5 lump, $16; 94 lump, $21; ground, 97, $35.

Foreign spar, duty paid, $17, tidewater.

FULLER'S EARTH — Per ton, f.o.b. *Florida:* 16 to 30 mesh, $16.50; 30 to 60 mesh, $18; 16 to 60 mesh, $17; 60 to 90 mesh, $14; 100 mesh up, $7.

Powdered, import duty paid, $24@$26 per ton.

GARNET—Per ton; domestic, f.o.b. mines, $85.

Spanish grades, $60, c.i.f. port of entry

GILSONITE — Per ton, carload lots, f.o.b. mines *Colorado:*

Selected grade, $33; seconds (mine run), $25.50.

GRAPHITE—Per lb., f.o.b. *New York:*

Ceylon lump, 8@9c.; chip, 6½@7½c.; dust, 3@5c.; Madagascar flake, 6½@7½c.

No. 1 flake, 8@16c.; fine ground, 5@15c. Ordinary fine ground, 4@6c.; high grade, 8@12c.; amorphous, 3@7c.

Crude amorphous graphite, $15@$35 per ton, according to grade.

GREENSAND—Per ton, f.o.b. cars, *New Jersey:* Screened and bagged, best grade, in carload lots, $20.

GYPSUM—Per ton, f.o.b. mill, depending upon location: Crushed, $1.50@$5; ground, $4@$9; agricultural, $4@$8; calcined, $4@$13.

IRON OXIDE (See Ocher)—Per lb.: Standard Spanish red, 3@4½c.; domestic earth, 2@4½c.

KAOLIN—See China Clay.

[1]LEPIDOLITE—Per ton: $20@$30 for ordinary grades. Nominal.

LIMESTONE—Per ton: f.o.b. shipping points, depending on location, either lump or crushed, 50c.@$3.

Agricultural, 75c. up to $5 for crushed or pulverized. Prices depend upon source, purity, and fineness.

MAGNESITE — Per short ton, f.o.b. *California* mines: Grade "A" calcined, 80 per cent through 200 mesh, $43; Grade "B," $40; dead burned, $29; crude $11. *Washington:* Dead-burned magnesite, $22@$24 per net ton, Chewelah, Wash.

MICA—Per ton, f.o.b. plant:

New Hampshire: Mine run sheet and punch, $320@$360; clean shop scrap, $15@$20; roofing, $21.50@$25. White dry ground, 20 mesh, $25; 40 mesh, $35; 60 mesh, white, $39; 100 mesh, $45; 200 mesh, $60. Granite mica facings for cement block and stucco use, $8@$12, depending on size between ¼ in. and 60 mesh. Disks, 1¼ in. No. 1, per lb., $1.25; 2½x2 in. square cuts, $3.25.

North Carolina: White, ground, 20 mesh, $35; 70 mesh, $100.

Madagascar, amber, per lb., f.o.b. *New York,* duty paid: No. A1, $2.50; No. 1, $2; No. 2, $1.65; No. 3, $1.15; No. 4, 60c.; No. 5, 45c.

[1]MONAZITE—Per ton: (Minimum 6 per cent ThO_2), $60.

OCHER — F.o.b. *Georgia* mines, per ton: $19@$20 in sacks; $21@$22 in barrels; washed and water floated, $18; second grade, 99 per cent through 225 mesh, $18.

PHOSPHATE—Per long ton, f.a.s. or f.o.b. mines:

Florida, pebble, f.a.s., for export: 76@77 per cent, $7.15; 75 per cent, $6.40; 74@75 per cent, $6.15; 70 per cent, $4.65; 68 per cent, $4.10.

Florida, pebble, domestic: 76@77 per cent, $6.50; 74@75 per cent, $5.50; 72 per cent, $4.50; 70 per cent, $4. Dull.

Tennessee, ground, 80 per cent through 300 mesh, 33 per cent P_2O_5, $12.80 per short ton. Brown lump for acid manufacture, per gross ton, $6.50 on 74 per cent basis; $5.50 on 72 per cent basis. Non-acidulated, fine ground, 65 per cent, $8 (per short ton).

POTASH—The ruling contract prices (short tons) are as follows:

	Bags	Bulk
Muriate of potash, 80@85 per cent, basis 80 per cent	$36.75	$35.15
Sulphate of potash, 90@95 per cent, basis 90 per cent	47.75	46.15
Sulphate of potash-magnesia, 48@53 per cent, basis 48 per cent	27.50	25.90
Manure salt, 30 per cent	21.95	18.95
Manure salt, 20 per cent	15.50	12.50
Kainit, 14@16 per cent	12.60	9.60
Kainit, 12.4 per cent	12.10	9.10

PUMICE STONE—Per lb.: In barrels, powdered, 2½@4c.; selected lump, 5@7c.

PYRITES—Per long ton unit of sulphur: C.i.f. United States ports; guaranteed 48 per cent sulphur: Spanish, 13c.; Tharsis, furnace size, 2½ in. diameter 14c. Cinder from ore to remain property of buyers.

[1]QUARTZ ROCK CRYSTALS—Per lb. in ton lots: Colorless, clear but flawed, pieces ¼ to ½ lb. in weight, 20c. Flawless, for optical purposes, four times above price; larger crystals still higher.

SILICA—per ton: Water ground and floated, in bags, f.o.b. Illinois: 325 mesh, $18@$40 for 92 to 99½ per cent grades. Market steady. Glass sand, f.o.b. producing plant, 75c.@$5 per ton; molding sand, 65c.@$3.50; blast sand, $1.35@$3.50.

[1]SPODUMENE — Per ton: $20@$30, depending upon lithium content.

SULPHUR—Per long ton for domestic market, $18 f.o.b. Texas mines; $22 for export, Atlantic ports.

TALC—Per ton, carload lots, f.o.b. works, containers included:

Vermont: 99 per cent through 200 mesh, extra white, bulk basis, $8@$8.50; 97 to 98 per cent through 200 mesh, medium white, $7.50@$8.

New York: Double air-floated, short fiber, 200 mesh, $13.75; 325 mesh, $14.75.

Georgia: Powdered, gray, $7.50@$10; yellow, $9@$12; red, $11@$13; roofing, $7.50@$9.

New Jersey: Soapstone, ground, $10@$12.

TRIPOLI—Per short ton, burlap bags, paper liners, minimum carload 30 tons, f.o.b. *Missouri:* Once ground through 40 mesh, rose and cream colored, $16. Double ground through 110 mesh, rose and cream, $18. Air-floated through 200 mesh, rose and cream, $27.50; mill run, $16. Demand quiet.

Rolled Metals

COPPER — Sheets, hot-rolled, per lb., 27¾c.; wire, per lb., f.o.b. mill, 19⅞c.

LEAD SHEETS—Full rolled, 8½c. per lb.; clipped, 8¾c.

MONEL METAL—Per lb., sheets, full finished, 42c.; rods, hot-rolled, 35c.

NICKEL—Per lb., sheets, full finished, 52c.; rods, hot-rolled, 45c.

ZINC SHEETS—Per lb., 10c., f.o.b. works

Refractories

CHROME BRICK—Per net ton, f.o.b. shipping point, $45.

FIRECLAY BRICK — Per M.: First quality, $43@$46, *Ohio, Kentucky, Central Pennsylvania;* second quality, $35@$38.

MAGNESITE—Brick, per net ton, f.o.b. works: 9-in. straights, $65, f.o.b. plant. Cement, $40, seaboard.

SILICA BRICK—Per M., *Pennsylvania* and *Ohio,* $43; *Alabama,* $51; *Illinois* $52.

ZIRKITE—Per lb.: Powdered, 65@70 per cent ZrO_2, 3½c. Brick, straights, 80c.@$1 each.

Metallic Compounds

ANTIMONY OXIDE—White, Chinese, 99 per cent Sb_2O_3, 10½@11c. per lb. Nominal.

ARSENIOUS OXIDE (White arsenic)—Per lb., 4c., delivered, all positions. Good call from glass and insecticide industries and prices are steady. London, per long ton, £15¾@£16 for Cornish white.

CALCIUM MOLYBDATE OR MOLYTE—Per lb. of contained Mo, 95c.

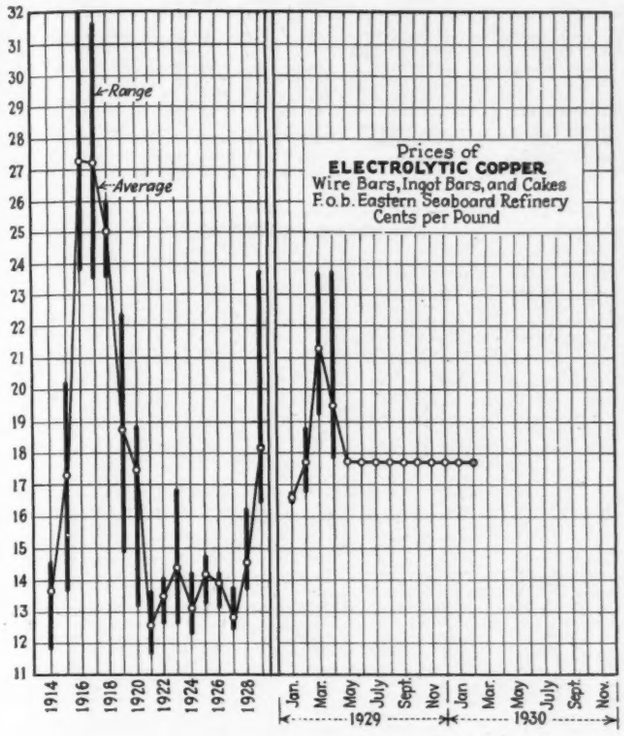
COPPER SULPHATE (Blue Vitriol)—Per lb. in car lots, 5½@6c. for either large or small crystals.

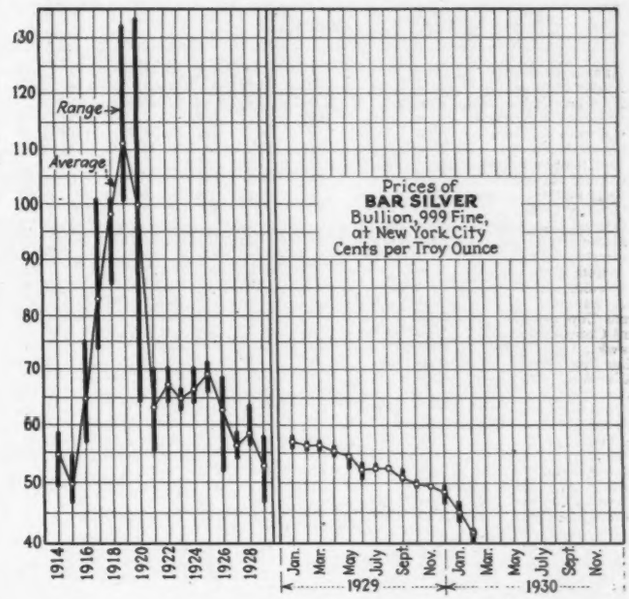
SODIUM NITRATE—Per 100 lb.; crude natural, in bags ex vessel, Atlantic ports, $2.16 for April deliveries.

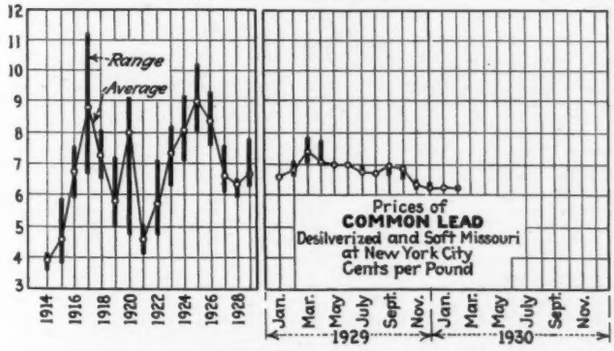
SODIUM SULPHATE (Salt Cake)—Per ton, bags, f.o.b. works, $22@$23; in barrels, $25@$28.

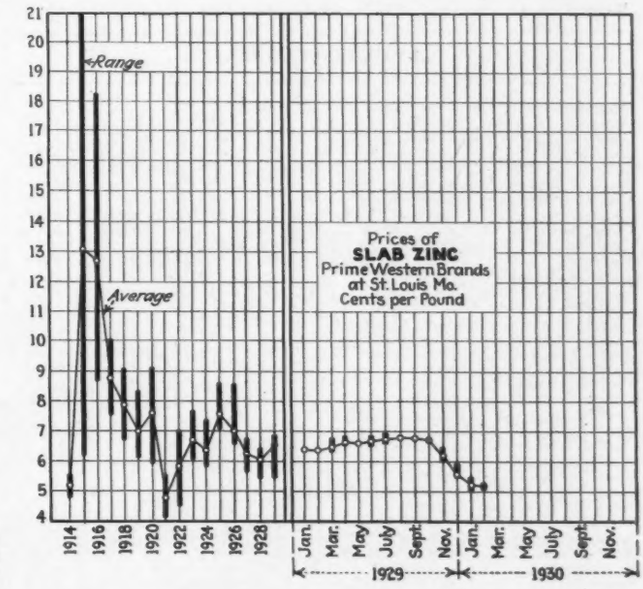
ZINC OXIDE—Per lb. in bags, in car lots: Lead-free, 6½c.; 10, 20 or 35 per cent leaded grades, 6⅝c.; French red seal, in bags, 9⅜c.

Metal Price Curves

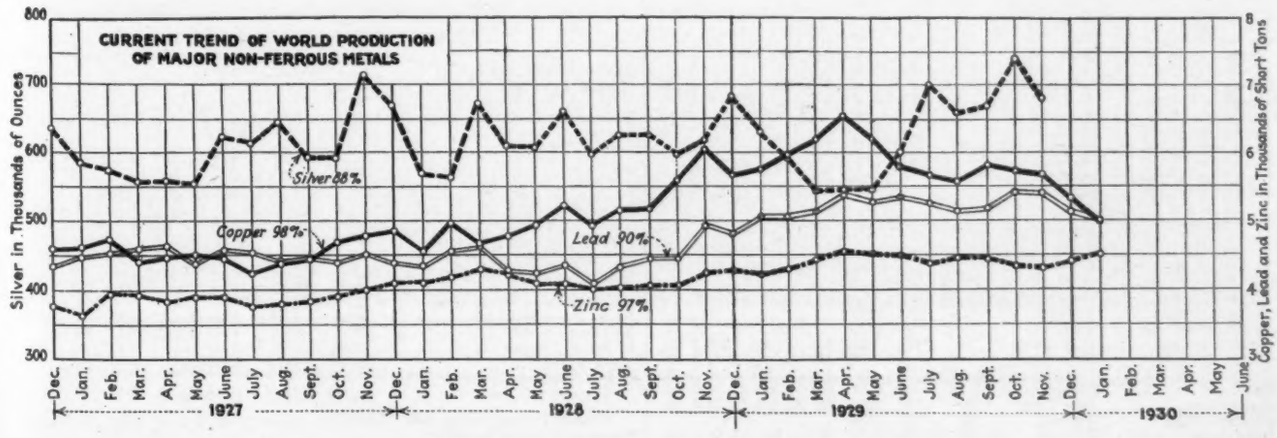








THE CURVES below are not to be considered as permanent records of production. They show merely the current trend in terms of daily output according to the latest estimates of the American Bureau of Metal Statistics. The figures represent production from countries that produce approximately 98 per cent of the world's copper, 97 per cent of the zinc, 90 per cent of the lead, and 88 per cent of the silver. The figures for lead on the new basis are not available for the individual months of 1926, and accordingly the horizontal line showing the monthly average reduced to a daily rate is shown. Delay in receipt of statistics from Mexico accounts for the failure of the silver curve to be up to date.


CURRENT TREND OF WORLD PRODUCTION
OF MAJOR NON-FERROUS METALS
Silver in Thousands of Ounces
Copper, Lead and Zinc in Thousands of Short Tons
Silver 88%
Copper 98%
Lead 90%
Zinc 97%
Dec. Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec. Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec. Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec. Jan. Feb. Mar. Apr. May June
1927
1928
1929
1930

Mining Stocks—Two Weeks Ending March 15, 1930

Stock	Exch.	High	Low	Last		Last Div.
COPPER						
Anaconda Copper	New York	76½	69½	70¾	Ja.11, Fe 17 Q	1.75
Andes Copper	New York	34½	30¼	31	Ja.11, Fe 10 Q	0.75
Arizona Commercial	Boston	1½	1½	1½	Ja. 16, Ja. 31	0.25
Calumet & Arizona	New York	82½	77½	77¾	Mr. 7, Mr. 14 Q	1.50
Calumet & Hecla	New York	30	26	26½	Fe.28, Mr. 31, Q	1.00
Cerro de Pasco	New York	61½	55	58	Ja. 16, Fe. 1 Q	1.50
Con. Coppermines	N. Y. Curb	7⅞	6⅞	6¾		
Copper Range	Boston	16	14¾	14¾	Mr.15 Ap. 25 Q	0.50
East Butte	Boston	1¾	1½	1½	No. 20, De. 21	0.25
Granby Cons	New York	58	52	53	Oc. 18, No. 1 Q	2.00
Greene Cananea	New York	....	....	112	Mr.13, Ap. 7 Q	2.00
Howe Sound	New York	39½	35¾	36	De.31,Ja.15 QX	1.50
Hudson Bay	N. Y. Curb	13⅜	12	12		
Inspiration	New York	38¾	28¾	36	De. 19, Ja. 6 Q	1.00
Isle Royale	Boston	11	10½	10½	Fe. 28, Mr. 31 Q	0.50
Kennecott	New York	60	54¼	54¼	Mr. 14, Ap. 1 Q	1.25
Magma Copper	New York	49½	47½	47½	De. 30, Ja. 15 Q	1.25
Miami Copper	New York	30⅛	28	28⅛	Fe. 1, Fe. 15 Q	1.00
Mohawk	Boston	48	45	46	Ja. 31, Mr. 1	1.50
Mother Lode	New York	1⅛	1⅛	1⅛	De. 9, De. 31	0.20
Nevada Cons	New York	30½	26¾	27½	Mr.13, Mr.31 Q	0.75
Noranda	N. Y. Curb	42½	39½	39½	Mr. 15, Ap.1 Q	0.75
Ohio Copper	N. Y. Curb	1.00	*87½	*87½	Sept. 1926	0.03
Old Dominion	Boston	9	8½	9	Dec. 1918	1.00
Phelps Dodge	New York	38⅛	36⅝	37⅛	Mr. 6, Ap. 1 Q	0.75
Quincy	Boston	41⅛	34⅛	38⅛	March, 1920	1.00
Roan Antelope	N. Y. Curb	28	25⅛	25⅛		
St. Mary's M. L.	Boston	25	23	23	Fe. 11, Fe. 25	2.00
Seneca Copper	New York	3	2½	2½		
Shattuck Denn	N. Y. Curb	9⅛	7⅛	7⅛		
Sherritt-Gordon	Toronto	2.88	2.40	2.81		
Tenn. C. & C.	New York	15	14	14⅜	Fe. 28, Mr. 15 Q	0.25
United Verde Ex.	N. Y. Curb	13½	12½	13½	Ap. 2, Ma. 1 Q	1.00
Utah Copper	New York	200	200	200	Mr.14,Mr.31 QX	4.00
Waite-Ack.-Mont.	Toronto	5.65	4.99	5.55		
Walker Mining	Salt Lake	4.00	3.75	3.75		
Wenden Copper	N. Y. Curb	*62½	*50	*56½		
LEAD, ZINC, SILVER						
Ahumada Lead	New York	*87½	*75	*75		
Amer. Z., L. & S.	New York	14⅛	12½	12½	May, 1917	1.00
Amer. Z., L. & S. pfd.	New York	72	67	67	Mr. 20, Ap. 1 Q	1.50
Bunker Hill & S.	N. Y. Curb	80	69½	69½	Fe.27,Mr.5, MX	0.50
Butte Cop. & Z.	New York	4⅛	3½	3½	De. 10, De. 25	0.50
Butte & Sup.	New York	5	3½	3½	De. 13, De. 31 Q	0.50
Callahan Zn.-Ld.	New York	1⅛	1½	1½	De. 1920	0.50
Chief. Cons.	Salt Lake	1.30	1.15	1.20	Fe. 1, 1918 K	0.10
Cons. Ld. & Zn. "A"	St. Louis	5½	5½	5½	Jan. 1930 Q	0.12½
Constitution	Spokane	*23	*15	*15		
Dayrock	Spokane	2.60	1.50	1.75	Je. 20, Je. 30	0.03
Dickens Consol.	Spokane	....	....	2½		
Eagle-Picher	Cincinnati	12⅞	12	12⅞	De. 31, Ja. 15 Q	0.20
Eagle-Picher, pfd.	Cincinnati	....	....	101	De. 31, Ja. 15 Q	1.50
Eureka Lily	Salt Lake	*33	*24½	*33		
Evans-Wallower	N. Y. Curb	6	4½	5⅛		
Evans-Wal., pfd.	N. Y. Curb	....	....	80	De.20, Ja.1 Q	1.75
Federal M. & S.	New York	....	....	175	June, 1927	10.00
Fed. M. & S., pfd.	New York	100½	100½	100½	Fe. 17, Ma. 17, Q	1.75
Golconda	Spokane	*80	*58	*58	Je. 15, Jl. 1,	0.02
Grandview	Spokane	*10⅛	*8⅛	*8⅛		
Hecla Mining	N. Y. Curb	12⅛	11½	11⅝	Fe. 15, Mr. 15 Q	0.25
Highland-Surprise	Spokane	....	....	*6		
Jack Waite	Spokane	*10⅛	*7⅞	*7⅞		
Kootenay Florence	Spokane	*3½	*2	*2½		
Lucky Jim	Spokane	....	....	*5		
Mexican Premier	Spokane	....	....	1.12	Ja. 5, Ja. 15,	0.01
National Lead	New York	184½	172	172	Mr.14, Mr.31 QX	4.25
Natl. Lead, pfd. A	New York	140½	139	140½	Fe. 28, Mr. 15,Q	1.75
Natl. Lead, pfd. B	New York	116	116	116	Ap. 18, My.1 Q	1.50
N. J. Zinc, new	N. Y. Curb	87⅜	84	87⅛	Ja.20, Fe. 10 Q	0.50
New Quincy	Salt Lake	*62	*36	*46	Se. 20, Se. 30 Q	0.10
Noble Five	Spokane	*13	*10	*12		
North Lily	Salt Lake	2.45	1.19	1.19	Ja. 16, Ja. 23, Q	0.15
Park Bingham	Salt Lake	*8	*5½	*6		
Park City Con.	Salt Lake	*39	*33½	*35		
Park Utah	New York	3½	2½	3	Dividends suspended	
Pend Oreille	Spokane	3.10	2.60	2.70		
Rico Argentine	Salt Lake	*9	*7½	*7½	No. 30, De. 15 Q	0.03
Ruth-Hope	Spokane	....	....	*14		
St. Joseph Lead	New York	55½	49½	49½	Mr.7, Mr. 20 QX	0.75
Sherman Lead	Spokane	*79	*49	*51	Mr. 20, Mr. 31	0.01
Silver King Coa.	Salt Lake	9.75	9.00	9.35	Mr. 12, Ap. 1	0.25
Silversmith	Spokane	....	....	*5	Oct., 1926	0.02
Sunshine Mining	Spokane	3.00	2.65	2.65	De. 10, De. 20 Q	0.08
Tamarack-Custer	Spokane	*55	*32	*32	Sept., 1924	0.25
Tintic Standard	Salt Lake	9.25	7.75	8.00	Mr.18, Mr.29 QX	0.30
Treadwell-Yukon	Toronto	6.00	6.00	6.00		
Utah Apex	Boston	2⅛	2½	2½	Oc. 15, No. 1	0.25
Utah Met. & Tun.	Boston	*58	*50	*50	Dec., 1927	0.30
Whitewater	Spokane	....	....	*15		
GOLD						
Alaska Juneau	New York	7⅛	7	7⅛		
Barry-Hollinger	Toronto	*24	*19	*21		
Central Manitoba	Toronto	*11½	*10	*10		
Cresson Consol.	N. Y. Curb	*50	*37½	*37½	Mr. 31, Ap. 10 Q	0.02
Dome Mines	New York	8⅛	7⅞	8⅛	Mr. 31, Ap. 21 Q	0.25
Golden Cycle	Col. Springs	†16.00	†14.75	....	Fe. 28, Mr. 10 Q	0.40
Hollinger	Toronto	5.70	5.65	5.65	Mr.11, Mr.25, M	0.05
Homestake	New York	79	76	76	Mr.20, Mr.25, M	0.50
Kirkland Lake	Toronto	*80	*75	*78		
Lake Shore	Toronto	23.00	22.25	22.75	Mr. 1, Mr. 15, Q	0.30
McIntyre Porcupine	New York	18⅛	17⅞	18	Fe. 1, Mr. 1 Q	0.25
Portland	Col. Springs	†*2	†*1⅛	....	April, 1927	0.01
Rand Mines	New York	36	36	36	Fe. 21, Fe. 28, A.s.	1.52
Siscoe	Toronto	*41	*37	*37		
Sylvanite	Toronto	*60	*55	*55		
Teck-Hughes	Toronto	6.40	6.10	6.35	Ja. 17, Fe. 1 Q	0.15
Tom Reed	Los Angeles	*94	*75	*86	Dec., 1926	0.02
Unity Gold	N. Y. Curb	*37½	*37½	*37½		
Vipond Consol.	Toronto	1.07	1.02	1.06	April, 1927	0.03
Wright-Hargreaves	Toronto	1.90	1.78	1.90	Oc. 16, No. 1	0.02½
GOLD AND SILVER						
Carnegie Metals	N. Y. Curb	6⅞	6	6		
Castle-Trethewey	Toronto	*16	*16	*16		
Keeley	Toronto	*35	*33	*35	Mr. 15, 1928	0.04
Mining Corp.	Toronto	2.99	2.85	2.90	De. 4, De. 19	0.12½
Montana-Mines Corp.	Spokane	....	....	*36½		
N. Y. & Hond. Ros.	N. Y. Curb	13½	12	12	Ja. 21, Fe. 1, QX	0.50
Nipissing	N. Y. Curb	1⅛	1⅛	1⅛	Mr. 31, Ap. 21 Q	0.07½
Premier Gold	N. Y. Curb	1½	1⅛	1½	Mr. 12, Ap. 4 Q	0.06
Tonopah Exten.	N. Y. Curb	....	....	*10	April, 1925	0.05
Tonopah Mining	N. Y. Curb	1⅛	1⅛	1⅛	Se. 30, Oc. 21	0.07½
United Eastern	N. Y. Curb	*25	*25	*25		
Yukon Gold	N. Y. Curb	*56½	*56½	*56½	June, 1918	0.02
IRON AND STEEL						
Bethlehem Steel	New York	105½	98	99½	Ap. 18,My.15, Q	1.50
Beth. Steel, pfd, 7%.	New York	131½	126½	131½	Mr. 22, Ap. 1 Q	1.75
Cleveland-Cliffs, pfd.	Cleveland	96	89½	91½	Mr. 5, Mr. 15 Q	1.25
Colo. Fuel & Iron	New York	59⅛	53⅛	57⅛	Fe. 10, Fe. 25 Q	0.50
Great Northern Iron.	New York	23⅛	22	22	Dec. 15 K	2.00
Inland Steel	New York	95	83	95	Fe. 14, Mr. 1 Q	1.00
Republic I. & S.	New York	78⅛	72	72	Fe. 11, Mr. 1 Q	1.00
Republic I. & S. pfd.	New York	114	112	112	Mr. 12, Ap. 1 Q	1.75
Sloss-Sheffield S. & I.	New York	40	35	40	Mr. 11, Mr. 20Q	1.50
Sloss-Sheff. S.&I., pfd.	New York	....	....	70	Mr.11, Ap. 1 Q	1.75
U. S. Steel	New York	184	177¾	179¼	Fe. 27, Mr. 29 Q	1.75
U. S. Steel, pfd	New York	144½	142½	144½	Fe. 1, Fe. 27, Q	1.75
MISCELLANEOUS						
Aluminum Co. of Am.	N. Y. Curb	318	310½	311		
Alum. Co. of Amer., pf.	N. Y. Curb	107½	106½	107	Ma. 15, Ap. 1, Q	1.50
American Metal	New York	49	44	44	Fe. 19, Mr. 1, Q	0.75
Amer. Metal, pfd., 6%	New York	114½	114½	114½	Fe. 19, Mr. 1, Q	1.50
Amer. Sm. & Ref.	New York	77	74½	75½	Ja. 17, Fe. 1 Q	1.00
Amer. Sm. & Ref., pfd.	New York	138½	134	138	Ja 31, Mr.1 Q	1.75
Ang. Ch. Nitrate	N. Y. Curb	21½	20	20⅜		
Asbestos Corp.	Montreal	3½	3	3	Jan., 1926	1.50
Asbestos Corp., pfd.	Montreal	15	9	14	De. 31, Ja. 15 Q	1.75
Consol. M. & S.	Montreal	240	226	226	De. 31, Ja. 15 X	6.25
Federated Metals	N. Y. Curb	23½	23	23	De.20, De. 30 QX	0.50
Freeport Texas	New York	46½	41½	44½	Oc. 15, No. 1 Q	1.00
Int. Nickel Can.	New York	42½	38	38½	No. 30, De. 31 Q	0.25
Int. Nickel, pfd.	New York	....	....	116	Ap 1,. My.1 Q	1.75
Mayflower Assoc.	N. Y. Curb	65	62	63	Mr. 3, Mr. 15 Q	0.50
Newmont	N. Y. Curb	134	119	125½	De. 27, Ja. 15 Q	1.00
Patino M. & E.	New York	29½	27	27	De. 7, De. 24	4s.
So. America G. & P.	N. Y. Curb	1½	1½	1⅜		
Texas Gulf Sulphur	New York	62½	59½	59½	Mr. 3 Mr. 15 Q	1.00
U. S. Sm. R. & M.	New York	33	29	30⅛	De. 31, Ja. 5 Q	0.87½
U. S. Sm. R. & M., pfd	New York	52½	51½	51½	De. 31, Ja. 5 Q	0.87½
Vanadium Corp.	New York	95⅛	69⅛	91	Fe. 1, Fe. 15, Q	0.75

Toronto Standard Stock Exchange, Toronto, courtesy the Arthur E. Moysey Co. Salt Lake Stock Exchange, courtesy J. A. Hogle & Co. and Logan & Bryan, New York; Standard Stock Exchange, Spokane, courtesy Pohlman Investment Company

*Cents per share. †Bid—asked range. Q, Quarterly. A. Annually SA, Semi-annually. M, Monthly. BM, Bimonthly. FW, Four weeks. K, Irregular. I Initial. R, Respumption. X, Extra. The first date given is that of the closing of the books; the second that of the payment of the dividend. A.s., American shares.

LONDON QUOTATIONS—ONE WEEK ENDING MARCH 4, 1930

	High	Low	Last	Date	Amount
Alaska Mexican ($5)	12/6	12/6	12/6		
Alaska Treadwell ($25)	42/6	42/6	42/6	Nov., 1926	4 d.
Aramayo Mines (25 frs.)	33/9	32/8½	33/9	Nov., 1929	5 c.
Burma Corpn. (10 rupees)	13/9	12/—	12/—	Feb., 1930	7 annas*
Bwana M'Kubwa (5s)	22/9	20/9	21/4½		
Camp Bird (2s)	1/—	—/9d	—/10½d	April, 1928	16⅔ p.c.
El Oro (5s)	2/3	1/9	2/—	Nov., 1929	20⅚ p.c.
Frontino & Bolivia (£1)	7/6	6/10½	7/6	Jan., 1929	3⅓ p.c.
Mexican Corpn. (10s)	9/—	8/4½	8/6	Oct., 1929	10 p.c.
Mexico Mines of El Oro (£1)	3/9	2/6	3/1½	Dec., 1926	3⅓ p.c.*
Mount Isa (£1)	25/—	22/9	23/9		
N'Changa Copper Mining (£1)	62/6	57/6	58/9		
Oroville Dredging (4s)	1/4½	1/4½	1/4½	Nov., 1928	31½ p.c.
Rhodesian Congo Border (£1)	305/—	287/6	290/—		
St. John del Rey (£1)	18/9	18/—	18/—	Dec., 1929	2½ p.c.
San Francisco Mines (10s)	22/9	21/—	21/—	Jan., 1930	22½ p.c.
Santa Gertrudis (£1)	10/—	7/10½	8/—	Jan., 1930	7½ p.c.
Selukwe (2s. 6d.)	4/6	3/7½	4/—	April, 1917	6⅔ p.c.
S. Amer. Copper (2s)	2/7½	2/3	2/4½	Nov., 1917	75 p.c.
Tanganyika (£1)	38/1½	35/7½	36/10½	July, 1929	7½ p.c.
Union Miniere du Haut-Katanga (Brussels)	8,250	7,650	7,650	April, 1929	300 fr. (‡)

*Free of British income tax. †Swiss francs and plus 15 p. c. bonus. ‡Belgian francs and free of taxation.